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## CIVIL ENGINEERING IN THE GAS INDUSTRY*

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IT is well, before embarking on schemes of integration and of large capital expenditure on new works, to find by actual results the 'rock bottom' price at which gas can be made at existing works. If reasonable facilities for coal supply exist, and if, also, there is reasonable mechanisation, particularly for handling coal from stores to retorts and for coke from plants to consumers, it may be very doubtful policy to construct extra plant at a neighbouring works and to supply the gas through new interlinking mains. Especially is this the case if the route of the new mains has already been covered by grid electric supply, as the present price of gas shows little advantage over two-part electric tariff, and additional consumers are very hard to gain.

In order to get manufacturing costs down to rock bottom prices it may be held that expenditure would be incurred that would not be justified if the works were eventually to be shut down. In view, however, of the delay in obtaining plant for new works, and the fact that in the interim period gas must be made, the extent of the work to be done to improve results is governed, or should be, by the extent of the improvement obtained. At works in bad shape the improvement will justify a considerable expenditure.

During the wartime fuel efficiency campaign, it was laid down that expenditure should be recouped by consequent savings in a period of two years. Fifty per cent. interest on capital!

In a number of works of all types visited it was surprising the amount that could be spent on work within that category. Much of the improvement work can also have a permanent value. For example, when a manufacturing station is shut down it can generally be used as a gasholder station, distribution stores, and work centre; therefore buildings, pumping plant, roads, mains, and embellishments with this end in view can be added or altered or made good without real debit to the limited gas-making life of the works in question.

The conversion of manufacturing stations to distribution centres had long been the practice of the Bournemouth Gas and Water Company, and is one reason why remote-control holder stations are not to be found in the area of the Bournemouth undertaking. At these converted works are gasholders, pumping plant, pressure regulators, local district stores and office, and a resident fitter in charge, whose duties include boosting and out-of-hours district calls. The local district inspector also lives nearby and is on the 'phone and centred at the works. In this way all plant is kept under continual observation, immediate action can be taken when required, and supervision of plant is only part of the duties of the personnel employed.

With the possibility, therefore, of being able to justify on economic grounds a reasonably substantial expenditure for putting smaller works in good order, it is as well to incur it before embarking too far on larger schemes of integration or, alternatively, to take into account the production costs at similar-sized works that are at the moment in first-class order, and to judge the minimum costs involved in bringing the other works into the same state, and the optimum cost of gas-making possible at that works.

There are, however, cases where shutting works down and supplying gas from elsewhere is a profitable measure, and the author instances an investigation into the advisability of shutting down Works Z in the Western Division of the Southern Gas Board, the alternative supply being *via* a new trunk main from Works D.

This was a rather special case, for three reasons. First, new gas-making plant for Works D, including an additional horizontal retort house of 1.5 mill. cu.ft. per day capacity and a carburetted water gas plant of 2 mill. cu.ft. per day capacity had already been decided upon; this plant giving a wide margin over future requirements, which included supplying gas to towns X and Y.

Second, the gas-making plant at Works Z consists of Morris scoop-charged, hand-drawn, stop-end retorts, which involve relatively high labour charge.

Third, new plant would be required at Works Z to cope with the growing demand for gas if gas were not supplied from Works D.

Three schemes were investigated, as follows :—

(*a*) Reconstruction of Works Z, including a new vertical retort house for all coal gas made.

(*b*) Reconstruction of Works Z, and the addition of horizontal retorts as required.

(*c*) The supplying of gas from Works D.

In assessing the financial aspects of the problem, the following procedure was adopted :—

(1) The gas outputs were assessed for the next 10 years.

(2) A summary was prepared of capital expenditure for the next 10 years for the three alternative schemes.

* From Communication No. 365 of the Institution of Gas Engineers, June, 1950.

(3) The present capital values of the works involved were ascertained, the yearly capital expenditure was added, and depreciation was allowed, so as to strike capital values for each of the next 10 years. From these figures, yearly charges of interest and depreciation were obtained for each of the three schemes.

(4) The cost of the production of coal gas and carburetted water gas related to the total quantity of gas produced and normal works conditions was estimated for each works, and from these the net cost of gas into holders was derived for each scheme year by year for the next 10 years.

(5) The costs of gas boosting and of the transport of coke incidental to the centralisation of production were calculated for the next 10 years.

(6) The costs of interlinking mains and the capital charges and depreciation were calculated, and

(7) The production, capital, boosting, and transport charges were summarised year by year for the next 10 years for the three schemes.

The calculations showed that by adopting scheme (*c*) (closing Works Z) a saving of £63,000 in seven effective years would be made on a gas production cost of £250,000 for the next best scheme. Scheme (*c*) also showed a saving of total capital expenditure of £28,000 over Scheme (*b*), and of £133,000 over Scheme (*a*).

If plant capacity had not been available at the larger works, if mechanically charged and discharged 'through' retorts had existed at Works Z, and if the same works had had reserve capacity, the picture would have been very different.

Each case, then, must be dealt with individually, and the method given above can be followed to obtain an assessment of costs that would be nearly accurate.

It may be held that the above is hardly civil engineering, but it is, of course, as all sound schemes must be based on as accurate an appraisement of the economic as well as other aspects as is possible.

## Works A

At present the river meandering through the centre of this works has prevented normal means of access and normal plant layout, and has cramped manœuvring space. It is now proposed to divert the river, and negotiations to that end are in the final stages, having occupied as much energy and time as may be required for the actual work of diversion.

This works was in very bad order. Everything needed overhauling, and half was fit for scrapping, including the retort house. Two alternative treatments that immediately came to mind were either the closing down of the works, or rebuilding.

To meet the demand for gas a carburetted water gas plant of 250,000 cu.ft./day capacity was transferred from a neighbouring works, and was put to work last winter just before a cold spell that otherwise would have caused a breakdown in gas supply.

This carburetted water gas unit was installed in conformity with the projected new layout, and becomes part of a self-contained carburetted water gas block comprising the following carburetted water gas components: House, relief holder, meter, exhausters, purifiers, and boiler house.

A new vertical retort house of 400,000 cu.ft./day capacity for later expansion to 800,000 cu.ft./day, with simple coal lift and coke-extraction plant, a new engine-room, and transferred washing and benzole plant located between it and new (probably dynamic) purifiers, would form a coal gas block, all machinery, gauges and controls being in the engine-room.

Coal would be piled in open store, with concrete wall sections high enough to contain the stock-pile base, and a mobile shovel would stack to pile and feed to the retort house. Coke bunkers and screens would be conveniently situated for the carburetted water gas plant, and adequate road access to both coal and coke piles is provided.

Extension of the offices and stores, and provision of fitting shop and garage complete the picture, these being needed, even though the manufacturing plant be shut down.

## Works B

This works was possessed, at vesting date, with a good retort house containing two beds of six stop-end, hand-fired retorts. Of the remainder of the plant, only the exhauster functioned with any degree of certainty. The washing plant had long since been abandoned, and the purifiers worked doubtfully, the covers being held down with odd pieces of timber and wire.

Two cast-iron tanks were made into purifiers at Bournemouth, together with Livesey and static washers, the latter from a length of 36 in. pipe. The equipment in the small exhauster, engine, meter, booster, and governor room was put together, including a gauge board. The plant was installed, connected to the inlet and outlet mains of the holders and to the town supply for an expenditure of about £2,000.

As an immediate and sustained result, thermal yield has risen by more than 10 therms per ton to 71 therms; gas is free from tar, naphthalene, $H_2S$, and ammonia, and with comparable improvement to the town supply mains an inevitable increase in consumption will still further justify the expenditure incurred.

## Works C

At Works C the labour position had resulted in a staggering accumulation of deferred maintenance work and rather bad conditions in the retort house, therms per ton being well below 60.

The horizontal settings (10 beds of eight 24 in. × 18 in. × 22 ft. through retorts with recuperators and built-in producers) were direct-fired, and, as a result, nostril arches of three beds had collapsed. Retorts were badly holed, stopped ascension pipes were common, and the hydraulic mains were full of pitch to the dip-pipe level. With difficulty, 700,000 cu.ft./day of gas was made in a house normally capable of producing 1.25 mill. cu.ft./day.

Roofs, woodwork, doors, and windows sadly needed attention. The pit of the coal elevators (outside the boots) was filled with coal, the pit covers being supported on the coal, the bearers having rusted away. Engines, motors, pumps, and machinery were all in bad shape, and water, steam, and other piping leaking and rusting. The electrical wiring was a source of constant faults, and the generator-engine jackets were practically solid with incrustation. Rubbish and junk were in evidence everywhere. Gas supply to the town was direct from two holders, and peak-load pressure was adequate only when the second and third lifts of the large holder were cupped.

A great improvement has already been effected, but certain major works are in hand, including the provision of a Congdon standpipe system in the retort house, Oldbury chain-grate stokers and induced-draught fan and dust collector for burning breeze fuel in the boiler house, town gas boosters to make town pressure independent of holder pressure, concentrated liquor plant, well pump, and water tower, new meters and connections for the separate streams of coal and carburetted water gas, electricity supply from the grid, *via* mercury arc rectifiers, complete new electric power and lighting circuits throughout the works, and the reformation of water and steam mains. In addition a carburetted water gas plant of 500,000 cu.ft./day capacity is being installed (having been transferred from the gasworks at Henley-on-Thames), together with a third exhauster, while there is also alteration of purifier connections to allow backward rotation of six purifiers now connected in sets of three.

There is also a comprehensive retort rebuilding programme.

Probably as a result of the work already carried out, and of an improvement in welfare facilities, labour difficulties have largely disappeared, and results have already improved by some seven therms per ton, with an additional seven within view.

At present, comparable efforts are being made on the distribution side, and it is logical to assume that a most substantial

increase in sales will result. It would not be surprising to see an increase of 40% within the next three years.

Choice of materials (*e.g.*, brick, concrete, steel) for civil engineering is governed by many factors, not all necessarily connected with suitability to purpose, chief of which is, perhaps, the availability or otherwise of cash.

Nevertheless, in considering the material to be used for a particular purpose, not only the immediate requirement should be borne in mind, but also any possible future use to which a construction might be put. Many a 'temporary' building has been found a permanent use and has thereby become a permanent disfigurement of its surroundings, possessed of questionable utility value. Many buildings have been erected without room for expansion, either internally or externally, and with a severely restricted future value. The realisation that a building needed for a temporary purpose might at a later date satisfy other needs is justification for the erection of a permanent structure conforming to good standards of appearance and design.

With works in such bad order as those mentioned previously, the expenditure of thought and energy makes a great show. On a well kept works one can spend just as much time and thought without half the apparent effect and without achieving half of the satisfaction gained from the comparatively limited enhancement of appearances.

The author on one occasion sought to obtain an extra therm per ton at one good works, only to find, when that had been done, that an assumed meter correction made the recorded result one therm less, and the amount of the unaccounted-for gas was shown at a more reasonable figure.

It has been equally hard in other undertakings in the Western Division of the Southern Gas Board's area to make any appreciable difference in the results or to make any striking betterment in the appearance of their works.

Too much emphasis cannot be laid on the importance of good layout, good architectural effect, good working conditions, good welfare facilities, a reasonable embellishment of lawns, trees and bushes, fresh decoration of workshops and offices, the elimination of scrap and useless plant, and on order and cleanliness. Appearance is not a negligible factor in the design of utility buildings for industrial purposes. It is very pleasing, therefore, to see the present trend in the design of retort houses, and it is certain that the extra cost of the better buildings is well justified. The industry should view with disfavour rusty corrugated iron and steel, smoke, soot and oil begrimed brick and concrete, clouds of dust, unswept roads and dirty machinery, and as far as is reasonably practicable steps should be taken to effect the necessary improvement.

Buildings should also be provided with adequate light and ventilation. Many dark places can be found on the majority of works. Many retort houses are built side by side with coal stores only between them, and no free space. Light and air can enter them only through the ends, or through the roof, and then only, in the case of light, if the glass is clean enough. Apart from limited areas, the rest is poorly or artificially lit and generally inadequately ventilated. The aspect of and working conditions in such places can be described as 'depressing.'

The reconstruction of the Poole gasworks will make a necessary change and be an example of the improvements advocated by the author.

## Contracts

Whether the contract be secured by a comprehensive bill of quantities and a price based on final measurements of the work, or by a fixed price for a job less formally described, the necessity for close supervision of the work is very important. This must be undertaken both by the contractors and by those paying for the work. A knowledgeable, vigilant, and capable clerk of works is essential, especially in these days when pride of craft is sometimes subservient to watching the clock and the wage packet.

Also, much depends on the contractors' agent and foreman; this has been most evident during the execution of two exactly similar contracts at places a few miles apart and carried out almost at the same time. On one of these jobs, despite the supervision it was possible to exercise, the work compared unfavourably with the other job, for which supervision by the undertaking was hardly necessary.

There is in the mind of the engineer responsible a very satisfying sense of security when dealing with agents, foremen, and workmen who are intent on doing work in a manner that will maintain and enhance their good reputation.

## Mechanisation

Mechanisation at small works is an important consideration (as, indeed, it is at large works), and the lowest 'all-in' running cost and simplicity should be the main objectives.

The transport of coal from Poole to Pitwines gasworks by the ropeway installed by the late Mr. P. G. G. Moon is an example of a simple solution of an awkward problem. Used until recently to transport 40 tons/hr., it was originally designed for 80 tons, which is the hourly capacity at the present time.

The ropeway overcomes differences in level and direction, occupies little ground space, works quietly and unobtrusively, creates very little dust, was constructed at a relatively low capital cost, and its running cost compares favourably with any other method. Though the author has described this ropeway as a 'simple solution,' it is well to remember that many simple solutions are very complex in their development.

The new layout for Poole gasworks also gives a simple arrangement for taking coal to and coke from the retorts.

It requires about two-thirds of the handling plant suggested for the alternative rebuilding of two houses in parallel, at right-angles to the arrangement shown. Poole and Pitwines are highly mechanised works, and use handling plant of considerable variety, from the 100 tons/hr. Mitchell transporter to the humbler Chaseside shovel; a large staff is required for maintenance, and a heavy cost is incurred for replacement and renewals. Hence the emphasis on all-in cost and simplicity.

The Ruston diesel works locomotive is worthy of mention. This engine, put into service in December, 1946, has been worked daily since then, and repairs have cost about £30 all told. It is not yet due for overhaul, starts up immediately in winter or in summer, does not burn fuel before or after use, can be stopped during intervening periods, and does not emit smoke, steam, grit or dust; it is, in fact, a most reliable and economical unit.

Various ideas have been tried for screening coke, and in this matter new ideas seem to be advocated very frequently; and, of course, it is claimed for every such new system that it will give the best results. Surprising as it may seem, there is a school of thought that believes progress from the inception of the rotary screen to have been *nil*. Certainly, the cost of maintenance of rotary screens compares favourably with later types, and the comparative efficiency of screening is most difficult to establish. This may be another field for practical research that would pay for investigation, together with means for elimination of coke dust, partially solved by the system employed on the new coke plant at Pitwines.

One aspect of particular importance is the moisture content of the coke. If this be slightly above the optimum it is impossible to dedust the various grades. If the coke is dry enough for dedusting it may not be efficiently quenched, fire may result in the bunkers, and dust nuisances at the bunker discharge chutes may be considerable.

## Thermal Efficiency

If the overall thermal efficiency of a gasworks be 75%, there still remains 25% of total heat to be accounted for, and after diminishing this heat loss by the theoretical process requirements there is a substantial residue of waste heat, expenditure upon the recovery of which may be well worth while.

Exhaust steam should be used for process, and where that is impossible electric prime movers should be substituted for steam engines. The reciprocating steam engine exhausting to atmosphere, as ordinarily seen in gasworks, is an outstanding example of thermal inefficiency. The turbine condensing unit is much better, but the back-pressure unit in which all the steam used goes to the retorts or carburetted water gas plants, or is utilised for some other useful purpose, is far and away the best.

The author once fitted a steam meter on a steam turbine driving a waste-heat boiler fan, and took a record of consumptions, maintaining the same waste-gas conditions when running to atmosphere through a boiler feed water heater and when throttling on the discharge to a back-pressure corresponding to retort steaming pressure. The unit worked normally under both conditions. Had the steam been used in the retorts under the back-pressure condition, a most substantial saving would have been made. It was thought, however, that the steam would not have been the same as that ordinarily used, which passes through a pressure-reducing valve. The difference, of course, is that the former steam is saturated and the latter superheated. To make the two equal merely needs a few superheater tubes in the inlet end of the waste-heat boiler, so as to add the few B.Th.U. to achieve the same degree of superheat in the steam from the back-pressure turbine as obtained by steam through the reducing valve. The advantage weighs heavily with the back-pressure turbine, because the retorts can use all the back-pressure steam, whereas there is only a limited requirement of heat for feed water purposes.

It should be possible to balance the electrical and steam power requirements with the process requirement in such a way that virtually no steam goes to atmosphere or to condensers, and none direct from boilers to process.

It is a pity that high-pressure boilers are so expensive, and that they are conspicuous by their absence in gasworks. When the order was placed for new boiler plant at Pitwines, the possibility was discussed of generating steam at high pressure and using it for generating electricity in back-pressure turbines. These turbines were to exhaust at a pressure just above the existing boiler pressure, the exhaust steam passing into the existing mains system, *via* a reducing valve, to give slight superheat. The cost of the high-pressure boilers, however, made the economic aspect rather doubtful, and this, coupled with local inexperience of high-pressure steam generation, caused the proposal to be abandoned.

The idea should be pursued, however, for the additional B.Th.U. required in the steam is relatively insignificant compared with the pressure rise and power obtainable.

Couple this suggestion with :

(*a*) The proven practice of medium-pressure turbines exhausting under back pressure to process;
(*b*) boiler feed water heated by the first stage of gas condensers;
(*c*) the elimination of all other than electrically driven prime movers, and with
(*d*) all steam, other than waste-heat steam, generated by breeze fuel, and a substantial rise in the works efficiency figure and a drop in cooling water requirements would be realisable.

An attractive suggestion for the utilisation of waste gases from the outlet side of waste-heat boilers was the subject of a provisional patent issued to the author in 1942. The proposal was that the hot waste gases should be used to warm coal so contained in a suitable vessel that it would be free to expand. The relatively low temperature used would be sufficient to invest the coal with a desirable non-swelling property as a result of this first stage of carbonisation. The second and final stage of carbonisation would be carried out in vertical retorts and at a lower temperature than is normal in standard high-temperature carbonisation practice.

In this way it might be possible to use retorts without taper and of refractory materials made without silica. It is possible that the yield of gas would be greater as a result of free passage from both stages of the process. A pilot plant would determine the effect on the coke.

Another proposal is to re-use the heat in the waste gases by raising their temperature and recirculating them. When a provisional patent was taken out for this idea by the author and his brother in 1946 it seemed as though theory was the only basis for faith in it. A paper on recirculation of furnace gases, read before the Institute of Fuel in 1948, however, gives practical demonstration of the possibilities of such a system in the success of recirculation development in connection with very large furnaces. The argument that the difference in steam made in the retort house will have to be made by solid-fuel-fired boilers is correct, but the fuel used can be of a much lower class, and, if the other recommendations made above are developed, the amount of steam required may be very appreciably less.

From time to time it has been necessary to balance the cost of electricity generation by gas, steam, and oil against supply from the grid. As the gas undertaking makes more steam in solid-fuel fired boilers than can be used for the generation of electricity, the cost of generation is charged with the cost of steam from the solid-fuel fired boilers. With breeze at 40s./ton, 7 lb. of breeze is used per kWh, or 37½ lb. of steam costing just over 1½d. Diesel oil at 0.63 lb. per kWh. and 1s. per gal. (plus running and maintenance) costs just over 1d. Cost of current from the grid averages 1.14d. per kWh.

A recently installed 300 kW. Harland four-stroke diesel generator set is therefore used for long periods.

## DISCUSSION

Mr. **Bernard Browne** (Regional Gas Officer, North Eastern Gas Board), who opened the discussion, observed that Dr. Johnston once remarked ' Depend upon it. The man who has a suspicion that he is going to be executed has his mind wonderfully concentrated.' On looking at the sea of faces in front of him he could not find one single favourable expression of his continuation. However, as most gas engineers had to possess poker faces, perhaps that did not amount to anything serious. He desired to assure the author that he was not going to execute him. Mr. Stredwick had mentioned in his paper the cost of natural gas in the Argentine capital. He had suggested that the cost of natural gas would be too high. Of course, that was an unwarrantable assumption. There was behind the supply the romance of 1,000 miles of 12 in. pipe which was laid across the Argentine Republic to bring the gas into the capital in less than 1,000 days. That was a national accomplishment, and if it had to be a surcharge on the price of gas, then the Argentinians would have great pleasure in paying. It was a question of national pride.

Mr. **J. T. Haynes** said that both Mr. Browne and himself had been responsible for authorising most of the works referred to by Mr. Stredwick, and obviously they could not adversely criticise schemes which they themselves had approved. It could, however, be said that the paper did not include the many alternative schemes which were discussed before final decisions were taken, and he paid tribute to the intense concentration with which Mr. Stredwick attacked all propositions which he was asked to investigate.

When the Pitwines gasworks at Poole was designed by Mr. Moon, the draft plans provided for a complete works approximately quadrupling the initial installation. That was unusual because most engineers were content to provide for duplication, but what was more unusual was for the engineer to see within his own lifetime the completion of such an ambitious scheme. Mr. Moon had the satisfaction of authorising, as resident director, the placing of orders for the final units of carbonising plant and other equipment planned in his original scheme and which had gone into production that year. Mr. Stredwick was Mr. Moon's assistant and the scope of service which Mr. Stredwick had seen during the last 13 years was probably unique in the industry, covering, as it had done, the extension of gasworks, the extension of water works, fuel efficiency inspection of many industries under the Ministry of Fuel and Power during the war, inspection and reporting on gasworks plant under the Gas Engineering Advisory Board and, during the past 12 months, the replanning of various undertakings of all sizes which needed attention in the Western Division of the Southern Gas Board.

### The Woodall Tradition

During the planning of the Pitwines gasworks, Mr. Moon was influenced by the views of the late Sir Corbet Woodall, and his son, Lieut.-Col. H. W. Woodall, both outstanding figures in the industry. At that time—25 years ago—they were of the opinion that spaciousness, cleanliness, and orderliness on a gasworks were so important that an expenditure of up to 2d. per 1,000 cu.ft. on that account was justified.

The natural inclination of the various gas boards had been towards integration, in accordance with the Gas Act; but the condition of many small rural gasworks, their small size and the time-lag and cost of obtaining gas mains, had made it necessary to put the works into reasonable technical condition to supply a consistently good quality of gas for the next few years, and to do that at a cost which would enable each undertaking to stand on its own feet financially if at all possible. Mr. Stredwick had quoted one or two examples, and the information which he gave could be supplemented by saying that his efforts and those of the chemical staff

had resulted in all their small works with hand-charged stop-ended retorts working two shifts a day maintaining on a recording calorimeter a line of 475 B.Th.U. gas as straight as many that were to be seen from a large machine-charged horizontal plant. Costs of gas into holder were coming down, and, more important, local managers were taking a pride in their jobs which was reacting on the public mentality towards gas in the rural areas to mutual advantage.

Mr. Stredwick had almost suggested that standard conditions of contract and the drawing up of bills of quantities in respect of all sorts of fiddling little jobs should be unnecessary, and that the necessity was a measure of the lowering of moral standards and business ethics during the last 20 years or so. In that connection Mr. Haynes said that his first reaction to the draft conditions of contract recently drawn up by the S.B.G.I. and circulated by the Gas Council was that they appeared to be designed to relieve the contractor of all responsibility in connection with a contract except that of collecting his money.

It was a pity that Mr. Stredwick rather summarily dismissed in a few words the subject of pre-stressed concrete. Certainly that was something of a novelty in this country, and so was re-inforced concrete 50 years ago; but there were many examples of that type of construction erected on the Continent during the last 10 years, and a number were now going up in this country. Members might be interested to know that at the present time the Bournemouth Corporation was erecting a bus station and repair shop which would have the longest span girder yet erected in pre-stressed concrete.

Towards the end of his paper Mr. Stredwick exhibited his restless search for increased efficiency; unfortunately the Bournemouth undertaking had no units of sufficient size to enable experiments to be carried out with some of Mr. Stredwick's more advanced ideas; but it was of interest to note that in other fuel industries there were installations which incorporated ideas similar to those suggested by the author.

## Experience at Ponders End

Mr. **E. O. Rose** (Tottenham Division, Eastern Gas Board) said he desired to support the plea made by Mr. Stredwick in regard to the place of the civil engineer in the gas industry. He was trained initially as a civil engineer, and he had noticed all through his life the difference in outlook and approach between the gas engineer who was trained initially as a chemist and the man who was trained in the first place as a civil engineer. The man who started life as a chemist commenced in his early days with a number of glass bottles and tubes. He tried one thing one way and if it did not work he tried it another way. In fact, he had often said to chemists: 'In future I shall put all your plant on wheels and give you some large diameter rubber tubing. If you are not satisfied with what I have done, you can then change it quite easily.' The civil engineer, on the other hand, had to start on the drawing board or in a works, and he could not change his mind. He had to consider everything down to the smallest detail before the project was launched. That was even more the case at the present time when vast sums were being expended and it was so important that no mistakes and costly experiments should be made. The civil engineer had to plan all his work in close detail as well as in the broad theme.

He thanked the author for bringing forward the necessity for cleanliness, spaciousness, clarity of design and bold simplicity. That was the only way in which a gasworks could be laid out. The figure of 2d. per 1,000 cu.ft. had been mentioned as being justified on that account, and it was certainly worth while. Under the direction of Colonel Smith he had recently completed the new works at Ponders End which were on a new site. Those works might have appeared extravagant, but they were now beginning to pay dividends. The whole site was paved, and there was no corner where some untidy person could spill tar or liquor or leave any rubbish. That was the type of works which was wanted, and it was fully worth while spending the money to get it.

Mr. **J. H. Dyde** (Vice-President of the Institution of Gas Engineers; Deputy Chairman of the Eastern Gas Board) remarked that there had always been good civil engineers in the gas industry among the contractors who had served the industry in the past. It was true that they had been associated mostly with larger organisation units, and it was because the new structure under nationalisation would tend towards an increase in the size of those organisation units that there would be more scope for the civil engineer in the design, layout, and construction of works plant. The Institution had apparently foreseen that development in the new examination system which was so closely linked with that of the Institution of Civil Engineers; but it must not be forgotten that once new works—for instance, at Ponders End—were built, essentially the same plant would be there in 30 years' time, and during that time a great deal of coal had to go through it. The process work had to go on, and gas engineers with training on the chemical engineering side and fuel technologists were needed to see that the raw material was properly processed and that the gas was efficiently made. Therefore, it was necessary to get a right bias on the complex nature of the industry insofar as it had to be served by gas engineers, physicists, and fuel technologists generally.

## Essex Integration Scheme

The author had given some most interesting examples of integration which were of very great use to those who had such things so much in mind at the present time. It would appear, however, that he answered the whole problem of integration in one sentence when he said that each project was an individual one and required individual financial treatment. The speaker had with him an extensive statement of an Essex integration scheme which was being embarked upon in the Eastern area, but it might be better to present it to the Institution as a written communication rather than to reel off figures, which were difficult to put over verbally, dealing with the cost of gas into holder of individual works, the cost of transmitting gas along the linkage mains, and so forth. Such problems were individual problems, and the deciding factor as to whether a works should or should not be shut down might resolve itself into a simple matter. It might be impossible, for instance, to dispose of the effluent, or the nature of the site might make it impossible to develop to an extent which would serve the growing population which was to be built around it.

Referring to the section which dealt with materials, layout, and design, the author had rightly stressed the need for good layout, architectural effect, good working conditions, and good welfare facilities. These were desirable in themselves, but they were conditional. One would hardly expect to have an expensive architectural structure with acres of glass like the Crystal Palace if the works were to be built in a purely industrial area, possibly next to a chemical works which was belching forth fumes. In fact, a building would not be erected over a coke oven. Coming to the other side of the picture, if it was necessary to continue to manufacture gas on a site in which the surroundings were residential—a typical case in point would be, say, Cambridge—efforts would naturally be made to produce an architectural effect which would be acceptable to the local and regional planners. There was the case at Willoughby Lane where the original conception of the retort house was to build an expensive architectural structure around it. It was felt, however, that it was not necessary, and that simply to clothe it with a roof structure would be sufficient. That produced a saving of 7½%, or £38,000 on a carbonising contract of a plant capacity of 8 mill. cu.ft. Local conditions must, in his view, play a part in the amount which one was prepared to spend.

A point in connection with coke screening plant which he found of interest was the author's comment upon the elimination from design construction of the rotary coke screen. The answer was that the reciprocating screen could deal with a far greater capacity per unit of screening service, and that it lent itself to sequence screening in a far better manner than the rotary screen.

## Balance of Power in Process Work

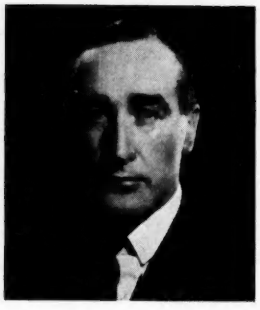
Another point of interest concerned the question of the balancing of power in process work. He found that in dealing with overall efficiency at many of the larger works, where one expected and found that the carbonising efficiency had been carried and the process efficiency generally of the manufacture had been carried to a considerable degree by close supervision, that the question of the balance of power with process steam and the corresponding use of electricity would determine the difference between one large works and another, and he was rather surprised that in the projected construction of the large works at Poole a case could not be made out for generating steam at high pressures, utilising back pressure engines for the generation of electricity, the back pressure being absorbed in process work. The extension at Willoughby Lane had an 8 mill. cu.ft. retort house, and there the boilers would be generating steam at 250 lb. pressure which would be used through back pressure engines for the generation of electricity.

An important point raised in the paper concerned the employment of gangs for gasholder painting. He regarded that as an analogous position to the employment also of retort setters operating from a large centre and being used for resetting or similar work. Both those arrangements had been considered attractive, and the feeling had been that they ought to be developed; but a major difficulty had been encountered with regard to human relations. It was found that his own squads of men would work quite happily as long as they could be transported to their work and home again at night. They were not the nomadic type which could be obtained from contractors; so, although the idea was a good one in principle, it was found that it was limited in practice.

# NEW GAS HEATING INSTALLATIONS*

By F. M. H. TAYLOR B.Sc., Ph.D., Assoc.M.Inst.Gas E.,

Managing Director, Thermocontrol Installations Company, Ltd.



THE gas-fired boiler plant for the concert hall being constructed as part of the London County Council's River Thames South Bank Scheme, which represents a total output capacity of 36 mill. B.Th.U., is one of the largest gas-fired installations in the country. The utmost precautions are being taken to obtain the highest efficiencies in the boiler plant, from which, through the use of an economiser, an efficiency of up to 85% may be expected, coupled with accurate control of the utilisation of the generated heat to ensure optimum economy.

The boiler plant consists generally of the following:—

(*a*) Heating boilers with automatic controls.

(*b*) Flue draught controls.

(*c*) Domestic hot water boilers with automatic controls.

(*d*) Economisers.

(*e*) Master automatic controls and instruments.

The boiler house has been divided into two sections: one for central heating of the building, and one for the provision of a domestic hot water supply.

## The Heating System

The heating system includes five Sinuflo vertical gas-fired boilers each 9 ft. in dia. and 9 ft. 6 in. high, and designed for operating on any pressure up to 75 lb./sq. in. The shells of the boilers are all welded, and below each of the 557 tubes is a gas jet; the gas jets are mounted on four quadrants, each mounted on special swivels.

The domestic hot water supply system includes three Sinuflo vertical boilers, 2 ft. 9 in. in dia. and 6 ft. 9 in. high, suitable for pressures up to 75 lb. per sq. in. Each boiler shell is fitted with 52 tubes, with a gas jet beneath each one, the latter mounted on a single burner frame that swings out for lighting and cleaning.

On the top of each boiler is a gas outlet chamber with individual flues leading to a main duct of 4 ft. 3 in. × 3 ft. 9 in. rectangular section, which leads all the waste products of combustion to the chimney *via* an economiser. There is also an electrically driven fan unit for inducing draught to the chimney, as well as a complete by-pass for natural draught requirement when, for example, electricity fails.

A very complete system of automatic control gear includes draught controllers at the outlet of each boiler and in the main flue, automatic gas valves (electrically operated) to keep the water at required temperatures, flame-failure safety devices, $CO_2$ indicators, night shut-down controls and an outside climate controller to reset boiler flow temperatures to suit weather conditions.

Fig. 1 shows the general lay-out of one of the boilers.

The following equipment (see Fig. 2) is fitted to each of three of the boilers:—

One 6 in. electrically operated gas valve, arranged to close on current failure.

One boiler temperature-limit thermostat to ensure that boiler water temperature does not rise above 190°F.

Four thermo-couple-type flame-failure safety switches (one to each boiler quadrant) interlocked with main gas valve so that the main gas burners and the pilot burners will be closed down in the event of flame failure on any one quadrant.

Four by-pass shut-down gas valves of 1 in. size to shut down on flame failure.

One interlock with the flue draught controller described below, so arranged that in the event of the flue pull falling below that required for safe operation of the boilers, such as through induced-draught fan failure, the gas valve will shut.

On each of two boilers (see Fig. 3) are fitted:—

Four 4 in. electrically operated gas valves, one for each boiler quadrant, arranged to close on current failure.

One boiler temperature-limit thermostat arranged to prevent boiler temperature exceeding 190°F.

Four thermo-couple-type flame-failure safety switches arranged each to close its respective 4 in. quadrant gas valve on current failure and to close pilot valves (16).

Four ½ in. pilot gas magnetic valves for closing-off low-flame gas supply to each quadrant on flame failure.

## Flue Draught Controls

Flue draught controls have as their object the maintenance of a constant flue pull on the flue outlet of each boiler of 0.02 in. w.g., with ±0.0025 in. w.g. when in operation. For this purpose an individual flue draught controller will be fitted to each boiler, but the main flue draught controller will be fitted to the main flue to stabilise main flue pull at approximately 0.03 in. w.g., irrespective of the employment of the induced draught fan or of the economiser. (See Fig. 4.)

The equipment provided consists of:—

(1) A flue draught controller placed in the main flue between the last boiler and the economiser; this maintains a constant flue suction of 0.03 in. w.g., approximately, under all conditions of load at the inlet to the economiser, by

(2) the operation of a louvred damper in the main flue on the inlet side to the induced-draught fan, which is operated by a pneumatic-hydraulic Delta controller that is capable of exerting a force of some 700 lb. on 8 in. movement, and will detect a change in the position of the sensitive element of 0.0002 in. This controller will give an accurate amplification of the controller signal strength of approximately 1 mill. times.

(3) A similar damper is fitted on the by-pass flue to the economiser and induced-draught fan, and will operate when natural draught only is employed. This damper will be operated by the same power unit previously described.

(4) On each of the uptakes from the boilers is arranged a hand-operated damper, which can be set according to the conditions of the plant in the initial adjustment of the plant.

(5) In each boiler uptake (five in number) there is a flue damper together with an automatic proportioning motor that is controlled by

(6) a draught controller placed in the uptake flue from each boiler on the inlet side to both dampers. This will operate the damper on the flue uptake for its respective boiler, in order to maintain under all conditions a flue pull of 0.02 in. w.g. on the top of the boiler.

The following automatic controls are included in the installation:—

* From Communication No. 368 of the Institution of Gas Engineers, June, 1950.

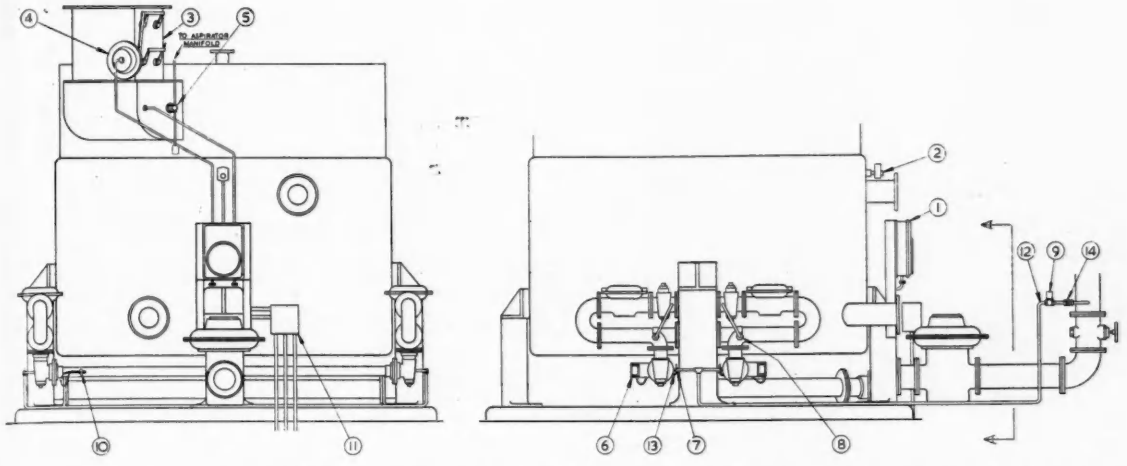



FIG. 1.—*London County Council South Bank Scheme:* 1951. *General Arrangement of the Thermo-Boiler-Controls on a 9 ft. "Sinuflo" Gas-fired, Vertical, Hot Water Boiler.*

(1) Flue draught controller.
(2) Immersion thermostat.
(3) Boiler flue damper.
(4) Air-operated lever motor, controlling damper.
(5) $CO_2$ sampler unit.
(6) Pilotstat flame-failure device.
(7) ¼ in. gas tap.
(8) ¾ in. magnetic valve.
(9) 1 in. magnetic valve.
(10) Bunsen burner for flame-failure system.
(11) Connector box.
(12) 1 in. gas pipe.
(13) ¼ in. flexible piping.

One main flow temperature controller, arranged for the boiler flow temperature to be as required for the calorifier load.

One step controller, so arranged that the boilers are brought on to load in sequence according to the requirements of the calorifier thermostat and the hot water load.

Night shut-down is by means of a valve on the secondary hot water circulation by a time switch mounted in panel.

One control panel, mounting a $CO_2$ indicator, the draught controllers, pilot lights for each boiler, and the step controller and time switch. Sequence boiler lighting is fitted to ensure that each boiler can only light in stages from low flame to main flame whether on hand or automatic operation.

The boiler controls and the flue controls are generally as described under (*a*).

The economiser is installed to utilise the flue gases from the gas-fired boiler to preheat the return to the boilers, thus effecting a fuel saving of 5 to 6%.

The economiser consists of a group of elements, provided with Senior extended heating surface, which incorporates the characteristic straight gas passage. Maximum heat transfer, with easy access for inspection and cleaning, is attained.

The machine is arranged in one group of 42 standard elements having a total heating surface of 1,663 sq. ft., a central baffle being fitted, by means of which, together with the appropriate dampering equipment, the heating surface can be adjusted to suit the varying amounts of flue gas available for preheating the water.

A steel frame houses the economiser, which is enclosed in insulated panelled steel casing, while access doors are provided at suitable points to facilitate inspection of the heating surface and connecting ducts.

A by-pass duct direct to the stack is provided, which enables the economiser and induced-draught fan to be isolated when necessary.

To overcome the friction caused by the passage of the flue gases through the economiser, and to compensate the reduction in draught due to the loss in temperature of the gases measured at the stack, brought about by the extraction and utilisation of heat by the economiser, an electrically driven induced-draught fan is incorporated in the plant.

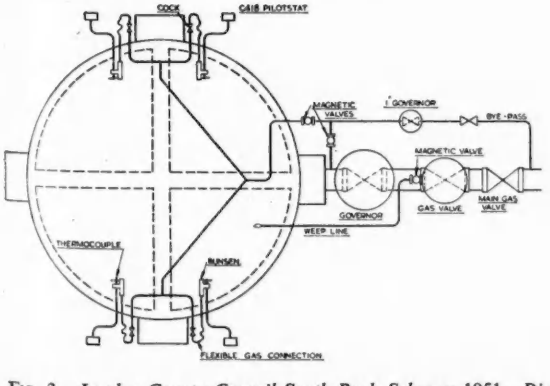



FIG. 2.—*London County Council South Bank Scheme:* 1951. *Diagram of 9 ft. Boiler, showing the arrangement of Gas Valve with By-passes and Flame-failure Device.*

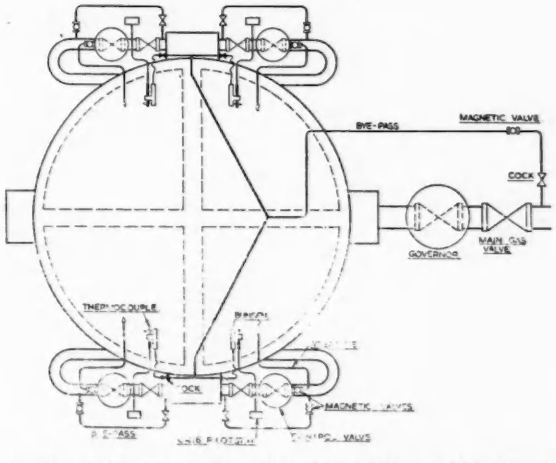



FIG. 3.—*London County Council South Bank Scheme:* 1951. *Arrangement of Gas Control Valves and Flame-failure Device as applied to a 9 ft. Vertical Gas-fired Boiler with control arranged in four quadrants operated by a step controller.*

Manual and automatic damper control enables the fan suction water gauge to be finely adjusted to suit the operating conditions of the boiler and economiser installation.

The following equipment is included:—

One main flow temperature controller, arranged for the boiler flow temperature to be as required for the heating requirements of the building, by compensator for outside temperature, but so arranged that the water flow temperature does not fall below 140°F.

One step controller, so arranged that the boilers are brought on to load in sequence of one quadrant or quarter boiler at a time according to the requirements of the building, in steps so that the whole boiler plant operates in 16 steps, assuming four boilers maximum in use at any one time.

The night operation of these boilers is carried out by a time switch, which changes them over to a low night setting.

One set of $CO_2$ flue gas analysis apparatus with change-over cocks is provided so that the $CO_2$ reading for any boiler can be tested to assist in the accurate setting of the flue draught controller.

Recording flow meter arranged for transmission to main instrument room. Distance reading thermometers and clock are also provided.

Two control panels, mounting the instruments, and a system of sequence lighting, pilot lights for each boiler, the step controller, and a sequence switch for arranging for each boiler to be stand-by in turn.

## Application of Gas Firing Equipment

There is a need for a standardised system of converting the sectional-type solid-fuel boiler to gas firing. Solid-fuel storage and handling difficulties, and the increased cost of stoking labour, have encouraged increasing numbers of users to accept the increased charges for gas fuel.

The objects are to convert existing boilers while ensuring the following essential conditions:—

(*a*) No alterations to the constructional parts of the boiler.

(*b*) The provision of a burner that will give readily maintainable efficiency of approximately 75%.

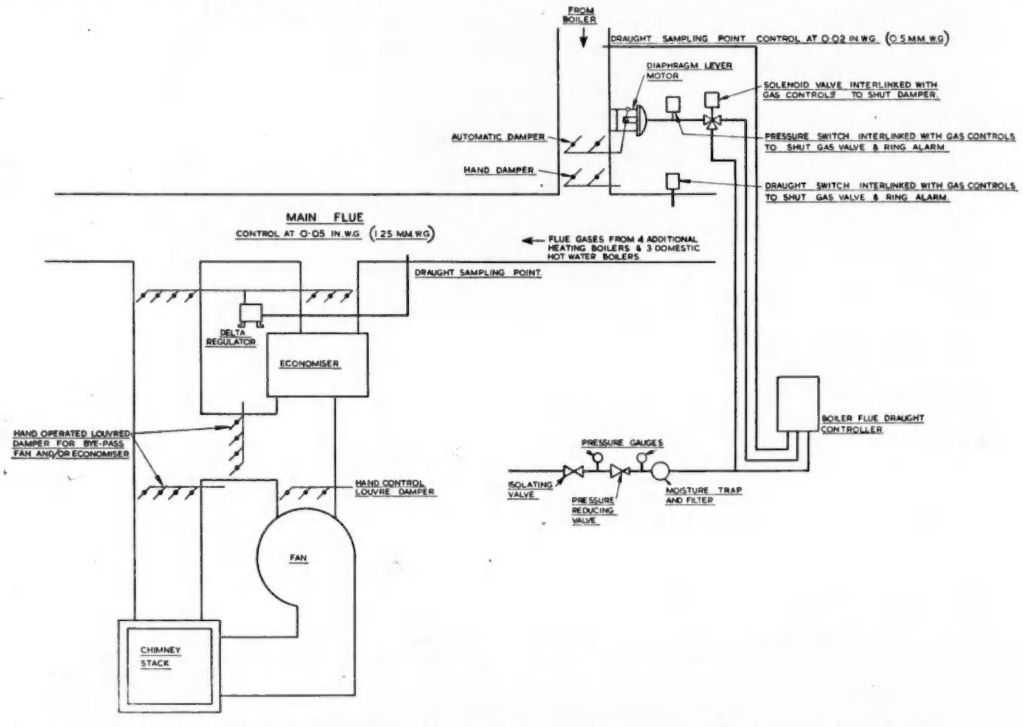

FROM BOILER
DRAUGHT SAMPLING POINT CONTROL AT 0·02 IN.WG. (0·5 MM.WG)
DIAPHRAGM LEVER MOTOR
SOLENOID VALVE INTERLINKED WITH GAS CONTROLS TO SHUT DAMPER
AUTOMATIC DAMPER
PRESSURE SWITCH INTERLINKED WITH GAS CONTROLS TO SHUT GAS VALVE & RING ALARM
HAND DAMPER
DRAUGHT SWITCH INTERLINKED WITH GAS CONTROLS TO SHUT GAS VALVE & RING ALARM
MAIN FLUE
CONTROL AT 0·05 IN.WG. (1·25 MM.WG)
FLUE GASES FROM 4 ADDITIONAL HEATING BOILERS & 3 DOMESTIC HOT WATER BOILERS
DRAUGHT SAMPLING POINT
DELTA REGULATOR
ECONOMISER
HAND OPERATED LOUVRED DAMPER FOR BYE-PASS FAN AND/OR ECONOMISER
HAND CONTROL LOUVRE DAMPER
FAN
CHIMNEY STACK
BOILER FLUE DRAUGHT CONTROLLER
PRESSURE GAUGES
ISOLATING VALVE
PRESSURE REDUCING VALVE
MOISTURE TRAP AND FILTER

FIG. 4.—*London County Council South Bank Scheme:* 1951. *Diagram of Flue Draught Controls.*

Showing position of automatic control dampers, together with hand-operated dampers and the local boiler flue control as fitted to each boiler, together with the arrangement of interlocks on the gas valve for closing the gas valve in the event of flue suction falling below the safe minimum.

(*c*) The design must be such that all parts or jets through which gas enters the burner must light one from the other, so that none can remain unlit.

(*d*) The burners must be capable of running for long periods without trouble from lighting-back even when the jets are hot.

(*e*) The whole gas-air mixture must be surrounded by refractory to maintain a high temperature until combustion is complete.

(*f*) The provision of a burner to which flame-failure protection can be readily applied.

(*g*) An assurance that the flame-failure cut-out is effective on both high and low gas flames.

(*h*) An assurance that relighting is always reliable, and in the light of experience perhaps most important of all.

(*i*) An assurance that, in lighting the boilers, automatic sequence lighting can be so arranged that the burners can be lit only in the following order:—

(1) Permanent lighting pilot.
(2) Low flame (either operating low flame or relighting low flame).
(3) Main flame.

Investigation of a number of explosions occurring in gas-fired plant has indicated that flame-failure is not a satisfactory safeguard unless combined with automatic sequence lighting.

(*j*) An air-control damper must be provided of sound mechanical construction, unaffected by heat, prefer-

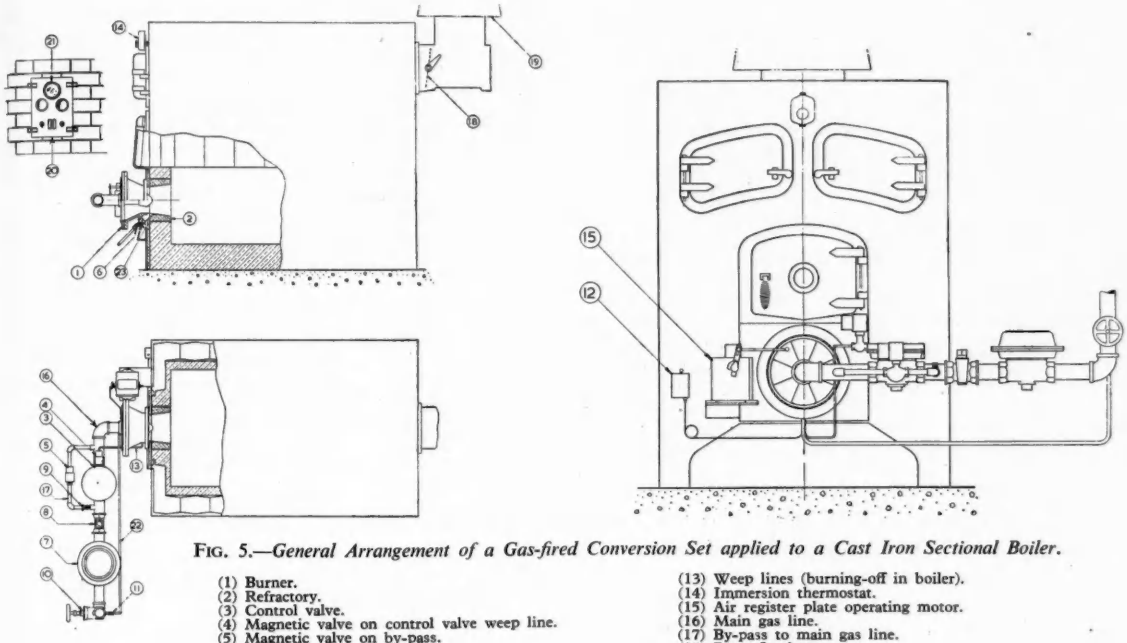


FIG. 5.—*General Arrangement of a Gas-fired Conversion Set applied to a Cast Iron Sectional Boiler.*

(1) Burner.
(2) Refractory.
(3) Control valve.
(4) Magnetic valve on control valve weep line.
(5) Magnetic valve on by-pass.
(6) Bunsen burner for flame failure.
(7) Governor.
(8) Trimming cock.
(9) By-pass cock.
(10) Main cock.
(11) Pilot burner cock.
(12) Pilotstat for flame failure.
(13) Weep lines (burning-off in boiler).
(14) Immersion thermostat.
(15) Air register plate operating motor.
(16) Main gas line.
(17) By-pass to main gas line.
(18) Butterfly damper.
(19) Baffle.
(20) Control panel.
(21) Time switch.
(22) Permanent pilot supply line.
(23) Thermo-couple operating flame-failure cut-out.

ably characterised by and with accurate linkage suitable for gas:air ratio control.

(*k*) Two indispensable features of all installations are that—

(1) All automatic control devices must move to the safe position in the event of any failure.

(2) All flame-failure and other protective devices must be self proving.

## Conversion of Hand-Fired Sectional Solid-Fuel Boilers to Gas Firing

The complete specification of the equipment as installed is given. The specification should be read in conjunction with Figs. 5 and 6.

The burner (1) consists essentially of gas inlet port and air inlet ports, which by internal construction are arranged to give mixing of the gas and air. Sufficient refractory (2) is incorporated in the mixing chamber to ensure that the heat of combustion is retained until the mixing and combustion processes are virtually completed.

The main gas inlet manifold and burner supports are of cast iron construction, and a mild steel burner mounting plate is fabricated so that the whole burner assembly can bolt on to the front of the boiler, replacing the fitting normally supplied by the boiler manufacturer. The angle to the horizontal at which the burner is fitted is critical and should be decided by engineers experienced in this work.

The air supply to the burner is normally controlled by an air register plate, operated by an air register plate operating motor (15), which is arranged to open the air supply before the main gas valve can open, and to close the plate after the main gas valve is closed. A small permanent opening in the air register plate is so arranged that the minimum air for combustion for the pilot bunsen burner and for the low-flame burner is ensured.

A section of the boiler water way is refractory lined, the object being to retain the heat in the partially burned gases until combustion is completed. Partially burned gases will not complete the combustion reaction if brought into contact with relatively cold water walls.

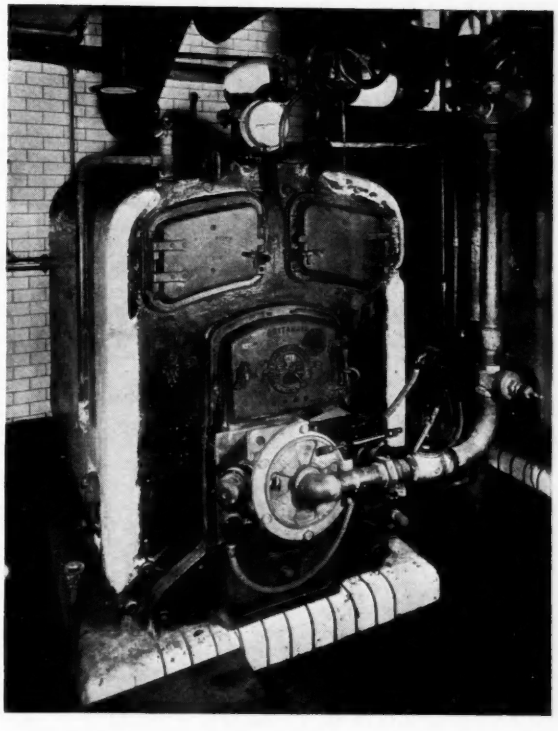


FIG. 6.—*Photograph of an Installation similar to that illustrated in Fig. 5.*

Showing gas-firing burner applied to cast iron sectional boiler with air register plate operating motor and boiler immersion-control thermostat, but with electronic-type flame-failure device.

A main relay-type control valve (3) mounted in the gas line is controlled in turn by a magnetic valve (4) in the weep line from the relay valve. A second magnetic valve (5) controls the low-flame burner and is used to shut the low-flame burner on flame failure, and acts as an integral part of the sequence lighting feature.

A bunsen burner with stainless steel tip (6) is mounted on a special boss entering the side of the main burner, and this serves to heat the thermo-couple tip of the flame-failure equipment. The standard gas service regulator (7) is fitted.

A gas supply trimming cock (8), which is used for setting the gas rate, and a by-pass cock (9), similarly used for adjusting the size of the low-flame burner, are provided, and in addition a main gas cock (10) so installed as to enable isolation of the whole system without altering the setting of the trimming cocks.

A separate line is taken to the flame-failure bunsen burner, which is controlled by a cock (11). A pilotstat, or flame-failure thermo-couple-operated relay, is provided, which is activated by a thermo-couple (23), which in turn is heated by the bunsen burner (6). Providing the flame is established, the pilotstat (12) makes contact, allowing the pilot gas valve and the main gas valve to be opened, but the main gas valve cannot open until the pilot valve has already opened. After the sequence lighting, the normal operation of the burner proceeds as required by the operation of the thermostat, of which the immersion boiler limit thermostat, normally set at 180°F. (14), is shown.

A hand-set butterfly damper is shown (18), as these are nearly always found on existing types of solid-fuel boilers that may be converted to gas. It is recommended that this flue damper be locked in a partially open position, and, although a flue baffle (19) is recommended, it is not always practicable to fit this, in which case a check draught damper is opened, or a permanent opening is made at the base of the flue. The size of this opening and the adjustment of the dampers is normally carried out by a $CO_2$ analysis when the installation is first put into operation.

A control panel (20) is recommended as a standard item supplied with this equipment, as it is preferable to house the relays, fuses, and the pilot lights showing whether current is established and whether the main gas valve is open, in a panel designed for the purpose. Frequently, a time switch (21) is incorporated in addition to shut down the boiler plant overnight or at week-ends. In certain cases a minimum to the low night setting is arranged so that the danger of over-cooling in cold weather, or of the freezing of the hot water system, is thereby eliminated.

The incorporation of the panel considerably simplifies the wiring and makes for easy maintenance of the installation.

The panel contains the sequence lighting arrangement whereby the pilot burner (6) is first lit. The flame-failure thermo-couple and pilotstat reset switches are then operated manually. On the relay operating proof is obtained that the pilot burner is established. Then, and only then, can the low-flame burner be opened through the magnetic valve (5), and finally, by operating the correct switch on the panel can the gas supply to the main burner be open so that the main gas flame lights directly from the low gas flame. The risk of failure to ignite, which might easily happen if the relatively small bunsen burner (6) is used as ignition pilot, is thereby avoided. Therefore, by the operator having to carry out the positive action of pressing a switch in the panel, which is some few feet away from the front of the boiler, there is no risk of a blow-back in the operator's face, as might happen if the operator were standing close to the front of the burner.

Many satisfactory test results have been obtained on this type of equipment, but the details of a typical test are included in the table in the next column:—

It may be noted in consideration of this table that in only two tests a $CO_2$ rating of less than 9% is obtained. The type of burner used in the installations with less than 9% $CO_2$ is a multi-jet type that the author would not now normally recommend, because in order to ensure complete combustion of the gas-air mixture without employing excessive quantities of excess air it is desirable to surround the combustion zone with a refractory to maintain a high temperature until combustion is completed.

The installation where the flue temperature is over 600°F. is where the boiler is, in the author's opinion, overrated for gas firing. It is frequently found advisable to limit the boiler rating down to approximately 80% of the manufacturer's rating, bearing in mind that the boilers, when using solid fuel, do not normally work above this figure.

The neat-type burner has been applied quite satisfactorily, with equally good results, to sectional and hot water boilers. The gas jets, set in a row, are easily capable of relighting one from the other, and the refractory surround enables the combustion to be completed before contact is made with cold waterways. The arrangement for flame-failure equipment also is made simple, and can be made to operate effectively and reliably. The low flame is stable and gives no lighting-back trouble and readily builds up to the main flame even after prolonged periods on low flame. The neat burner is ideally suited for modulating control.

Similar results to those illustrated have been obtained with with installations equipped with a neat burner.

## High Pressure Hot Water Systems

The application of gas firing to high-pressure hot water systems has many advantages because of the great flexibility required in these systems. The plants are normally of 6 mill. B.Th.U./hr. and upwards capacity.

On the larger installations it has been usual, in employing solid fuel, to employ combustion control—that is, to adjust the flue air ratio to give the highest combustion efficiency. This can be done in gas firing by two control motors working in parallel, one to adjust the gas valve according to the load required, the other to adjust the air inlet damper.

A more comprehensive system giving very much closer control is carried out by means of an air-flow regulator, which will vary the air flow according to the output of the boiler measured by a B.Th.U. meter. The gas rate is governed by the high-pressure hot water pressure, or by its flow temperature.

*Report of a Gas Test carried out in February, 1949, at Hampstead, with Thermocontrol Equipment on 26K Britannia Boiler.*

| Gas rate | $CO_2$ % | $O_2$ % | CO % |
|---|---|---|---|
| 500 cu.ft./hr. | 9.6 | 5.3 | Negligible |

Flue gas temperature, 525° F.
Calculated flue loss, 21%.
Boiler efficiency, 79% (less boiler radiation losses).

A further table showing some comparative results of the same types of boilers is shown as follows:—

| Type of boiler | Flue gas analysis $CO_2$ % | $O_2$ % | CO % | Flue temperature (°F.) | Flue loss % | Gas rate (cu.ft./hr.) | Maker's rating (B.Th.U./hr.) |
|---|---|---|---|---|---|---|---|
| Ideal New Classic NC.72 ... | 9.0 | 5.6 | Nil | 620 | 23 | 264 | 104,600 |
| Ideal Britannia 26K... | 9.6 | 5.3 | Nil | 525 | 21 | 500 | 241,000 |
| Ideal Britannia 26K... | 7.6 | 7.0 | Nil | 580 | 24 | 580 | 241,000 |
| Crane Whitehall 3-8 ... | 7.6 | 7.2 | Nil | 550 | 24 | 1,260 | 523,000 |
| Ideal Britannia 26K... | 10.4 | 3.8 | Nil | 440 | 18 | 486 | 241,000 |
| Robin Hood Crier, 10-section ... | 10.0 | 4.5 | Nil | 770 | 25 | 1,800 | 730,800 |
| Ideal Britannia 17K... | 9.2 | 5.1 | Nil | 520 | 21 | 375 | 165,000 |

## The Dowtherm Industrial Process

Where heating is required at temperatures of the order of 500° to 600°F. for industrial processes, in which very accurate control is required, non-volatile liquids stable at relatively high temperatures are employed as heat transfer media. They have the advantage over high-pressure hot water or steam in that, in transmitting heat at high temperature,

they require relatively low pressures, normally of the order of 50 lb./sq. in.

In these installations the gas is controlled by a modulating valve on a modulating pressurestat or thermostat. Flame-failure and oil level control are similar to those used in high-pressure hot water installations, but in the case of flame failure the cut-out is so arranged that a momentary flicker of the gas flame will not lock out the system, and a delay of a second or so is employed. This minimises the risk of cooling a valuable product that might be spoilt if the supply of heat stopped before the chemical reaction were completed. A very high degree of accuracy in the temperature control of the reagents may be obtained by this process, without any risk of local over-heating.

## Clothes Drying Cabinets

Public housing authorities are now providing tenants of blocks of flats with laundry facilities consisting of a battery of washing machines, together with drying rooms for the drying of clothes. Similar equipment has been installed commercially in 'laundrettes.' The drying equivalent of approximately 15,000 cu.ft. of unheated space (approximately two whole flats) can be provided by a gas drying cabinet costing less than £1,000, and consisting in effect of seven separate cubicles, one housing the gas burner, air supply fan, and the controls, the other six acting as air-heated drying cabinets. One small drying cabinet with two chambers only for the clothes is described:

The towel drying cabinet is constructed of aluminium sheet with angle stiffeners as required. The finish is cream enamel.

The plant consists of two cabinets, each cabinet arranged to hang 10 bath towels, weighing 1½ lb. each, wet, or ¾ lb. dry. The time required for drying is 30 min. The size of the complete unit is 6 ft. 8 in. high, 5 ft. wide and 2 ft. 6 in. deep. The rail space available is over 20 ft., the rails being arranged in tiers to allow easy access. Entry of the warm air is arranged from the top of each cabinet, and extraction from the bottom. On opening either cabinet door the volume of air passing through the cabinet is reduced to approximately 10% of the normal flow.

The heating system includes an impeller-type fan rated at 500 cu.ft./min. and driven by a totally enclosed 1/3 b.h.p. motor of capacitor-start, induction-run type, on 230 V single-phase supply. Fan and motor are mounted on top of the cabinet. The fan capacity is designed to take a maximum resistance through the system of 1 in. w.g. The gas burner has a rating in gas of 100 cu.ft./hr., and the output is 48,000 B.Th.U. The equipment is provided with an automatic control valve arranged to close the burner to approximately one-third main flame by means of a thermostat in the return air duct, set at 150°F. approximately, and by a limit thermostat set in the distribution duct, set at 180°. A humidity controller is also provided. On normal operation, 50% of the air entering the cabinets is recirculated, and 50% drawn from the fresh air. Also 50% of the air leaving the cabinet is passed to atmosphere. The incoming air is filtered to ensure removal of dust. Two 4 in. dial bimetallic helix-type thermometers of range 0° to 200°F. are provided.

## Industrial Refrigeration

Although the domestic-type gas-operated refrigerator has been known in this country for some years, the industrial type has only been employed in the United States of America. The principles are the same as in the domestic type well known to the gas industry.

The cost of operation compared with compression-type refrigeration plants operated on electrical power is greater on gas than on electricity if standing charges be ignored. If it be borne in mind that the total power consumption or gas consumption for a cinema over a year for refrigeration may only be £250, for electricity the charge for current is £100 to £150, but the standing charge alone on electricity adds another £200, thus making an attractive case for gas-operated plants for this load. Alternatively, the same type of absorption refrigeration plant can be operated by a hot water coil from the coke central heating boiler, which in the summer would not be needed for heating purposes.

## Power Generation

The generating of electrical power or direct mechanical power by gas-fired internal combustion engines has not shown any notable expansion in the past 25 years. It has, however, many advantages where electric power rates or conditions of supply are not attractive to the user. The overall efficiency of this process can be increased from approximately 25% for power generation only, up to as high as 70% by the use of waste-heat recovery by which the engine cooling water and waste heat from the exhaust gases are recovered and used for central heating or for hot water purposes. A typical lay-out of such a system includes the automatic controls necessary for regulating the temperatures, and makes provision for cooling the water when the heating load is not sufficient to balance the waste-heat rate.

It is felt that the users of gas for generating electric power would be very much more satisfied with their installations and certainly with overall costs, if they were to couple waste-heat recovery with their generating plants.

# DISCUSSION

**Mr. R. L. Greaves** (South Lancashire), in opening the discussion, said he shared the author's belief in the expansion which would continue generally throughout the country in the use of coke providing suitable special appliances, backed by fully qualified technical advice, continued to be devised and publicised. For that reason it might not be out of place for some mention to be made of the down jet system of combustion, which had not been mentioned by the author.

Since 1939 that system of combustion using coke had been the subject of research in the furnace department of the British Coal Utilisation Research Association's laboratories at Leatherhead. In 1948 it was considered that research was sufficiently advanced so far as coke burning was concerned to make it available for commercial development, and early in 1949, a Wolverhampton firm entered into an agreement which gave them the right to manufacture and market Down Jet equipment in accordance with B.C.U.R.A. patents.

The principle of Down Jet combustion had been found so intriguing that the South Lancashire Group of the North Western Gas Board had decided to publicise the system. The result was that the largest industrial Down Jet furnaces yet installed were recently put to work in the factory of one of the board's largest industrial consumers.

## An Important Development

The outstanding report of the manufacturers on first test was that fired by that method, 7½ tons of coke per week could do the work of 20 tons of hand-fired coal per week with greater efficiency and less labour in their case, so that while after the first trial there were certain adjustments to be made to the furnace in question, the board were confident that an important new method of burning coke had been discovered, and one which might even exceed the initial claims made for the system by the Research Association and the manufacturers. He had also inspected a Down Jet furnace satisfactorily firing a central heating installation with, in his view, several advantages over any other method and with, it was claimed, greater efficiency.

While he agreed with the author that automatic firing of coke was desirable, unsuitable automatic firing devices brought not only coke but also the system of coke burning into disrepute, and there had been outstanding failures with automatic firing so far as maintenance and satisfaction to the consumer were concerned.

For many reasons, therefore, the new Down Jet furnace appeared to be the most promising new special appliance for the combustion of coke. Twenty-five of those furnaces for central heating firing were being manufactured immediately and put to work in various areas. If they were successful, as no doubt they would be, production, it was understood, would then commence at a suitable rate. In the meantime, the number of industrial Down Jet furnaces at work for various utilisations continued to grow steadily.

Coke fuel was fed by gravity into the Down Jet furnace from a

sealed storage hopper, forming a bed inclined at the angle of repose. A controllable jet of air discharged through a nozzle impinged on the surface of the bed and penetrated to a depth of several fuel particles. As combustion proceeded, the fuel particles were reduced in size and were replaced by fuel from the top layer over which fresh fuel fed continuously from the hopper.

The combustion chamber volume required was very small, and it was possible so to proportion it to the rate of heat release as to obtain complete combustion with practically no excess air and to obtain correspondingly high temperatures, 1,650° C. for example, with cold air, but that temperature could be exceeded where suitable refractories were obtainable; indeed a reducing atmosphere might also be produced if required.

At the depth of a few particles below the surface of the bed, temperatures well above the melting point of the ash were reached, and the drops of molten ash formed in that region gravitated downwards through the hot coke until they reached a zone where the temperature was low enough for them to coalesce and freeze to form a saucer-shaped clinker. Facilities were provided for removing the clinker periodically, either in a simple manner by hand or where justified automatically.

In his view more success was likely to be obtained by controlling the air blast and clinker removal than by feeding stokers with worm feeds conveying coke.

## Fields of Application

Fields of application with the Down Jet were (i) central heating; (ii) industrial drying; (iii) metallurgical furnaces, and (iv) firing of special refractories, &c. The principal advantage of the coke fired Down Jet was the low fuel costs owing to high combustion efficiency. By that method coke was a cheaper fuel than coal and was even claimed to be cheaper than oil.

On the question of coke size suitable for that system, while a proportion of say 1½ in. by 2 in. was desirable, the presence of smaller sizes down to ½ in. was not objectionable, and the manufacturers had promised to conduct and report back on tests with ¾ in. by ½ in. coke. It was important to note that in the main the manufacturers preferred the coke not to exceed 2 in. or specified size dependent on the size of the furnace.

Mr. **L. W. Andrew** (North Thames) said that the ambition of those concerned in the industry was that gas fired equipment, among other requirements, should operate at the maximum possible practical efficiency and with complete safety even under abnormal conditions of use. The desirable number and nature of controls and the extent to which they should be fully automatic would depend on many practical factors, but it seemed reasonable to suggest that the larger the installation the more important it was to take the fullest advantage of completely automatic and comprehensive controls. Dr. Taylor was a real enthusiast for automatic controls, and the speaker desired to pay tribute to the oustanding part he had played in fitting controls which affected both practical efficiency and safety of operation.

The size of the boiler had no terrors for him, and it was right and proper that he should be in the position to present members of the Institution in such detail with the layout of the very large heating system for the concert hall of the 1951 South Bank scheme. A debt of gratitude was owed to him for having gone to so much trouble in providing really detailed information. It was no light task to have prepared 27 pages of detailed diagrams.

## Real Safety

It was pleasing to note, too, that the author had not been hypnotised by his love of automatic devices for their own sake, and had laid down the purposes underlying each control. He reminded members that safety devices should not only be safe, but fail safe. Perhaps one might go a little further and always ask the following questions about each control as it was fitted, ' Is it necessary ? ' ' Is it foolproof ? ' ' What maintenance does it need ? '

While the author avoided controversial issues of actual gas boiler design, it would seem that inherent in the paper was the desire to reduce to a minimum the number of jets in a gas-fired boiler in the interests of easier maintenance, more certain ignition, and easier application of flame failure devices. That trend was a welcome one.

It was important to keep the whole question of controls in perspective, and he felt sure that Dr. Taylor would excuse him if he suggested that the paper was primarily concerned with the larger installations, where the provision of the maximum number of controls would still form a relatively small proportion of the total cost of the whole installation. While paying tribute to the author on that side of his paper, he appeared to be rather less happy, or should one say, he lost the master touch on smaller boilers and on the normal domestic appliances.

The references to conversion units were of great interest at the moment, as they not only represented an important application of gas, but in the past there had been too little consistency, either on the types of controls fitted and the sequence of controls, or the precise method of conversion adopted, with the result that there were installations which would not please the author from the point of view of control, and on which the combustion margin might not be all that was desired.

As far as the smaller central heating units were concerned, it might be wise to consider not only the perfect forms of control, but methods of improving simple and cheap flame failure devices, the position and type of permanent pilots, easy lighting instructions, and smooth ignition from permanent pilots. He might appear to represent the belt and braces school, but he confessed to a feeling of great security when he knew that the first step in lighting a boiler was to ensure that permanent pilots were alight and readily visible.

Very little reference was made in the paper to the flue problem, and any information on any difficulties met with in practice, and their solution when the heating unit operated at an efficiency of 80% or even greater would be welcomed.

Reference was made to the importance of correct sequence of lighting from pilot, low flame, to main flame, and it would be of interest to know at what rating of boiler the author considered that to be an essential requirement.

## Refractory Linings

To consider one or two points of detail in the paper, it was not clear whether or not the author recommended that refractory linings were always needed for conversion units in order to attain complete combustion, as there were installations in which complete combustion was assured before the gases were in contact with any water-cooled surface. It would also be interesting to know to what extent the author made use of chequer brickwork in boilers fired from a single jet.

It was interesting to note the recommendation of automatic control of the air inlet to the boiler, and members would doubtless be interested to know whether or not there were any practical snags, and to what extent such a control was a real gain if an on-off system of working were adopted.

The author made wise use of timing cocks, but it was to be hoped that any such devices were permanently locked in position by an authorised person.

The author referred to the operation of boilers by quadrant burners, and it would be of interest to know what the effect was on efficiency if the boiler were operating at, say, one quarter its normal rate. A little later he limited the use of on-off working to an extent which would not normally be regarded as essential, and there was a tendency in fact to use on-off working to an increasing extent. Although it was agreed that safety devices should fail safe, it might be necessary at the moment to compromise on appliances of low rating.

The capital cost of the drying cabinets suggested appeared, at first sight, to be excessive for the duty performed, and it might well be that there was a real need for a robust single type of direct fired gas-heated drying cabinet with mechanical installation only.

In conclusion he reiterated his belief in the importance of reducing the number of individual jets required to operate a gas-heated boiler, whether a conversion unit or not; and in that connection it would be interesting to know the extent to which the author had met with any practical difficulties in jets lighting across tubular burners from the low flame setting. It was to be hoped that he would be forgiven for reminding the author that during his recent experience in the elections at Gravesend, he expressed the hope that controls would go! First class controls and simple controls were needed.

## The Load Factor

Mr. **R. J. Pepper** (North Thames) said the truth of a remark by the author that ' although the ideal load factor is 100%, the only sure way of reaching it is by distributing continually diminishing quantities of gas ' could not be over emphasised. If the activities of the electrical industry were viewed, it would be seen that little attention was paid to load factor when new business was sought. The policy would appear to be first to increase consumption and then deal afterwards with the problems arising from the increase.

That might appear to be unsound and it was certainly not in the best interests of consumer service; but, when the problem arose,

it appeared to be met by cuts at peak loads and then a clamouring for the construction of additional plant.

The consumption was obtained first and the plant followed, and was deemed the secondary consideration, and that policy appeared to achieve satisfactory results.

The gas industry could not overlook that important factor and he was convinced that the sale of gas should be the first object. The price of modern fuels made that a more simple problem than pre-war, as gas consumed in efficient modern appliances compared more favourably with solid fuel at prevailing costs than was formerly the case.

In addition there was no dust or dirt which was a very big factor in these days when domestic labour was difficult and costly to obtain and tended to make space heating by gas a most attractive proposition.

In the case of water heating, his own experience was that an instantaneous multipoint water heater was cheaper to run than a solid fuel slow combustion stove when the purpose was only to obtain domestic hot water, there being no space heating required.

## Consumer Reaction and Response

The time had come when the industry could profitably advertise space heating and let the average consumer know more about the progress which had been made in the design and performance of modern heaters and other appliances.

Previous commercial experience had shown that consumer reaction and response was not immediate, and it would probably take several years for the public to become more gas-minded in relation to modern gas appliances; but by that time it was hoped that the industry would be in a position to supply the extra gas required, and that the increased consumption would at the same time be a means of budgeting for more and more plant, and so enable the gas industry to maintain and increase its prestige by continuing to increase the output of gas; all by-products including coke being a secondary consideration.

Mr. **H. R. Hems** (Industrial Gas Officer, West Midlands Gas Board) said he was pleased to notice that more attention was being given to the utilisation side of the industry which, with respect, he sometimes felt was not put into its proper perspective.

Again, the way in which the author came out into the open and indicated that before very long the industry was going to have a far greater field of competition than had perhaps been the case in the past was something to be admired. Dr. Taylor was a very interested and very active co-operator in the work of the industry, and as an interested observer, those engaged in the industry must take note of what he said.

On the question of staff, there were several points of agreement between Dr. Taylor's paper and that read by Mr. Carr at a previous session, and he was hoping to have some opportunity in written discussion to say a little more about that.

The actual installations which the author had put forward were really difficult to discuss. They were complete installations—except for the Festival one—and it was very difficult to discuss them in detail. It would be helpful if, on some future occasion, the author could take the readers a little behind the scenes. For instance, he was no believer in instrumentation for the sake of the instrument, and he would have liked the author to relate, if possible, the cost of the installation and heating plant to the cost of the instruments, and to indicate when the instruments, to the extent that he had put forward, were really justified.

Again, what standard of intelligence did the author expect from the operator who was placed in control of plant of the type which he had indicated? Also one might ask what type of difficulty or complaint were the author's service engineers confronted with on those installations?

## Flame Control Devices

On the question of flame control devices the author was touching on a serious point. The work of the Industrial Gas Development Committee was concerned very vitally with that question. Certain recommendations were being sent out by the Ministry of Labour, and it was felt that in view of those recommendations a move might have been made to get out a little too much in front of the development of the actual instruments to meet all—and he stressed the word 'all'—cases which were visualised in that memorandum. It would have been interesting to hear from the author, with his vast experience, more of the practical experience and difficulties with such devices, particularly as applied to some of the small plants of which Dr. Taylor had had experience.

It would appear that the author's burner installations—that was where he applied his fuel technologist experience—were mainly confined, as far as one could see, to one type. It would be interesting to learn the reasons for that, and whether at some time later on Dr. Taylor could perhaps enlarge on some of the other types of burners which were known to be available.

Reference had been made to investigation of a number of explosions which occurred in a gas fired plant—'Investigation of a number of explosions occurring in gas fired plant had indicated that flame-failure is not a satisfactory safeguard unless combined with automatic sequence lighting.' The author would doubtless include correct fitting in the preliminaries to that remark. It would be interesting to know whether those were applied to the type of installations to which he had referred, or whether they referred to more general types such as had been included in the Ministry of Labour recommendations.

Mr. **W. S. Stredwick** (Southern Gas Board) said that an installation for getting heat from waste gases by internal combustion engines similar to one illustrated by the author, could be seen at the Avon Waterworks of the Bournemouth Water Company.

At those works there were two 650 h.p. two-stroke diesel engines which exhausted their gases through Thimble Tube waste-heat boilers. The water circulated through the boilers, part going to heat the building and part going to supply hot water and central heating service for four dwellings on the pumping station site. The water returned to a thermostatic control valve and either passed direct to the boiler or, if flow line temperature were too high, part went to a cooler in the inlet water culvert of the pump. There was no necessity to provide a special cooler, because the means for that were already there, of which advantage was taken. The thermostat in the return water operated an oil fired boiler so that if the heat demand differed from the heat available from waste gas, the oil-fired boiler could make up the deficit. The performance with clean boilers was sufficient to provide normal winter day heating and hot water demand from waste gases of five therms an hour for the building, and three therms an hour for the dwellings. That was when one engine was at work.

## The Author's Reply

Dr. **Taylor**, in a brief reply, said that Mr. Greaves had very properly drawn attention to the Down Jet coke furnace, and it was very gratifying to hear of the progress which had been made with it. The Down Jet furnace was in some respects a development of the methods of gravity feeding with control of the fuel depth.

Mr. Andrew raised a number of important points and asked what the author's opinion was concerning multi-jet or single-jet burners-cum-boilers. As far as his own experience was concerned, the single-jet burner had proved more satisfactory not only from the point of view of efficiency, but also from the point of view of safety.

With regard to flues, one of the tricks of a contractor was not to take on a job unless he thought he could make a success of it, and whenever he came across a commercial job in which there was a flue problem, his practice was to say 'Do not convert that to gas.' Where there was plenty of flue draught it was fairly simple to arrange for a large excess of air from the boiler house to be sucked up the flue, and that was sufficient to take up all possible condensation and still go flat out for boiler plant with high efficiency.

A question was also asked concerning refractory lining. The reason he was extremely keen on refractory lining was because in some earlier experiences of gas burners he found that for some peculiar reason air and gas were prevented from mixing properly in boilers where the air came into contact with the cold steel wall. For some reason the air seemed to be attracted to the wall of the boiler and the gas was repelled. There did not appear to be any known explanation for that, with the result that the tendency had been to keep the gas/air mixture wrapped up in refractories until the combustion had been completed.

One or two speakers referred to automatic controls. He had a commercial interest in automatic controls so he ought not perhaps to speak for them; but there was one fundamental consideration in connection with them. If controls were not to be chosen properly and fitted properly and then maintained properly, they would not be put in at all. There were hundreds of thousands of control installations working in this country, and there were millions in the United States. The average cost of a control installation applied to an industrial central heating job worked out at something over 10%, although the tendency at the present time was for it to creep up to something like 15%. The cost of maintaining it over a 12- or 15-year period was a fraction of 0.1% of the control installation. It cost, in other words, something like one one-hundred-thousandth part of the whole job.

# RECENT PRODUCER GAS PRACTICE IN THE LIVERPOOL UNDERTAKING

**The following is the discussion on the Institution Paper by Mr. W. S. Hubbard, M.I.Mech.E., M.Inst.Gas E., Gas Engineer, Liverpool Undertaking, an abstract of which appears on p. 865 of Part 1 of this issue.**

DR. J. Burns, G.M. (North Thames Gas Board), who opened the discussion, said it was evident that the author was an enthusiast, particularly so far as the mechanical producer was concerned, and he hoped that he would not be considered completely old fashioned if he ventured some mild criticism with regard to the use of mechanical producers.

The author was, of course, entitled to ask: 'Upon what experience do you base your criticism?' The North Thames Gas Board started with mechanical producers in 1930 when, on the recommendation of the late Mr. Thomas Hardie, nine mechanical producers were installed in conjunction with the coke ovens at Beckton. Mr. Hardie, who was a very long sighted gentleman, made provision at that time for testing all types of fuel in mechanical producers, and during the last 20 years various types of fuel had been tested from boiler nuts to breeze and up to coke in mechanical producers. As a result of that, he could corroborate that which Mr. Hubbard said about the use of different types of fuel.

Mechanical producers had been very successful indeed. In fact, they had been so successful that the North Thames Gas Board had repeated the dose, and there were now 18 mechanical producers in association with coke ovens carbonising some 2,400 tons of coal per day. He raised the matter in order to bring out a point concerning the cleaning of producer gas which was one of the more difficult problems. It caused a lot of headaches in the first place in that there were a lot of dust deposits in the generators of the coke ovens, and a lot of work had to be done in order to solve the problem of gas cleaning. The general principles which it had been found possible to apply for the successful cleaning of gas were, first of all, adequate cooling in washer coolers, and at that point reference might be made to the fine work done by Mr. Dougill, the Deputy Station Engineer at Beckton. When it came to the use of mechanical producers in conjunction with retort houses he was prompted to venture his mild criticism. So far as he was able to judge, the principal improvement put forward for the mechanical producer in that case was better working conditions which it afforded to the operators; but the question of better working conditions had to be put in proper perspective. He suggested that the order of priority in the matter of good working conditions for operatives in retort houses was, first, coal travel. It was important that coal travel should be right, because if it were bad, then the work of the operators was very difficult. He also suggested with great respect to the new phraseology that retorts had to be kept dynamic as well as purifiers. Second, he suggested the dust problem. That was a real problem not only from the point of view of operatives in the retort houses, but also from the point of view of the amenities in the surrounding neighbourhood. The North Thames Gas Board were on the way towards solving that problem to a degree. and most of the vertical retort houses had some form of dust ex- tractıon plant.

## Adequate Ventilation

Third on the list of priority came adequate ventilation. There was no doubt that a lot of gas was being burned for heating, and full use must be made of heat economy in order to recover high temperature heat. That still left the problem of low temperature heat which had to be removed by adequate ventilation.

After adequate ventilation he suggested that some thought might then be given to mechanical producers. The step grate producer was not a bad form of producer. The operation of the step grate producer was no more arduous, and provided it was adequately designed with plenty of air to give constant fire conditions, it could be a very efficient form of producer indeed.

**Mr. S. K. Hawthorn** (Birmingham) said that the paper was very timely as it focussed attention on a technique and a policy which were not new in their application to the gas industry, yet had largely been ignored in the past. The author and his undertaking were to be congratulated on their boldness in introducing mechanical producers in such a big way in Liverpool, and in giving the industry such comprehensive information on their experience.

Until quite recent years the installation of mechanical producers for retort heating did not, on balance, appear to offer any attraction over step grate producers unless coke breeze could be gasified and attempts to do that had met with very limited success. Gas engineers accepted with reserve accounts of successful gasification of breeze because breeze was such a wide term, inferring no more than an upper size limit which might be as high as ¾ in. While the author did not advocate breeze as a mechanical producer fuel, he gave a limit of 40% through ¼ in. for successful gasification (at a restricted rate) but breeze from low rank coals carbonised in continuous vertical retorts might contain up to 50% through $\frac{1}{16}$ in. It was not being realised that mechanical producers could often be an attractive proposition, if not a necessity in certain circumstances, when gasifying graded coke.

The main advantages were the elimination of arduous fire cleaning by hand, which varied with the type and quantity of ash in the coke, the ability to use small graded coke, which was less saleable than the larger sizes, and the assurance of a constant quality and quantity of producer gas. The disadvantages which had previously been over-stressed were high capital cost and loss of sensible heat which was assumed to involve higher fuel consumption.

The author had indicated in Table 5 a substantial reduction in fuel consumption on continuous vertical retorts at Linacre after changing over to mechanical producers, although as yet his experience on horizontal settings was not so good in that respect.

## Constancy of Volume and Quality

It was his view that in assessing the probable fuel consumption in mechanical producers as compared with step grates too much emphasis had been placed on loss of sensible heat, and too little emphasis on the constancy of gas volume and quality. Steady conditions could not easily be maintained on a step grate producer between fire cleanings, because the resistance of the fire bed would vary. Such variation was commonly counteracted by automatic control of steam to venturi air inlets to maintain a constant producer gas pressure. That variation in steam, however, altered the steam/air ratio and altered the gas composition, although the pressure might remain constant. The best that could be done with step grates was to admit a controlled steam/air mixture by fan, but that could not entirely nullify variations within the fuel bed. It was quite possible, therefore, that more fuel was wasted by variable fire conditions than was required to compensate for the lower gas temperature from mechanical producers.

Experience in Birmingham with mechanical producers for retort heating was limited to six months on a 4 mill. cu.ft./day installation of Glover West retorts equipped with Glover West mechanical producers, but it could be confirmed that the fuel consumption was surprisingly low. It could also be confirmed that the carry over of dust into the flues was considerable. The information given in the paper on the Centicell dust catcher was of particular interest.

A point not perhaps brought out in the paper was the need for the closest collaboration between the designers of the setting and the mechanical producer manufacturers if they were different firms. Generally it would seem inadvisable to substitute mechanical producers for step grates without modification to the retort heating arrangements. Another point of considerable importance was the provision of adequate ventilation on the producer operating stages. Mechanical producers required a reasonably spacious layout and should not be crowded into a restricted space.

The application of producer gas as a diluent, except on some small works with horizontal retorts only, appeared to have been looked upon with disfavour almost to the point of being considered by some engineers as unprofessional practice. Fortunately that prejudice was disappearing, and he agreed with the author that producer gas dilution could have its place in the best engineering practice. Over the past two and a half years, mechanical producers for dilution had been installed at each of the four Birmingham works with great success.

It was decided to adopt a policy of high throughputs and high C.V. in continuous vertical retorts combined with producer gas dilution as a means of increasing manufacturing capacity quickly. That policy had increased the gasmaking capacity of the undertaking from 92 to 100 mill. cu.ft./day at a capital expenditure of

approximately £600,000. The four producers were purchased from the Ministry of Supply and were gasmaking in periods varying from 4½ to 9 months from the date of purchase. By no other means could gasmaking capacity have been increased to the same extent in so short a time and at so little cost.

He could entirely confirm the author's experience of the application of P.G. to peak load gas production. His undertaking had, on occasions, increased C.W.G. quality to 600 C.V. and operated the producers at overload without difficulty.

No complaints had resulted from variation in combustion characteristics, although there had been isolated instances of slightly inferior pressures at times of extra peak load. Those extra peak loads were, however, of short duration and did not even occur every year. It was surely more economical to meet those occasional high peaks by unorthodox methods involving little in capital expenditure, than to install additional carbonising plant or even C.W.G. plant which must operate at a very low load factor.

## Birmingham Producers

The Birmingham producers consisted of (1) a power gas 9 ft. unit operating on coke nuts of 1 in. by ¾ in., with semi-cleaning plant producing up to 3 mill. cu.ft./day. (2) A Welman Smith Owen Galusha Agitator producer 10 ft. 6 in. diameter operating on non-caking nut coal with semi-cleaning and cooling plant giving a C.V. of 165 and capable of producing at least 4 mill. cu.ft./day. (3) A 9 ft. diameter I.F.E. producer also operating on coal nuts, and with semi-cleaning and cooling plant, and producing 2½ mill. cu.ft./day, up to 170 C.V. (4) A 6 ft. diameter Power Gas producer operating on coal nuts with similar cleaning plant and producing 1 mill. cu.ft./day at 165 C.V.

All those plants were originally designed to gasify coke, but three of them were converted to operate on non-caking coal, and all had worked extremely well. When using P.G. as a diluent, there was a substantial advantage in using coal and attaining a C.V. of 165/170 as against 125 when using coke. In addition the cost of non-caking coal nuts was lower than graded coke.

All the plants were fitted with automatic volume control arrangements capable of immediate adjustment for correction of final C.V. of mixed gas. All plants also included washer coolers with water circulation systems and centrifugal cleaners. In the case of producers operating on coal, they centrifugal cleaners were fed with coal gas tar direct from the retort house tar and liquor separators and no tar troubles had arisen. The producer tar amounted to about 3% of the total tar leaving the retort house. The semi-cleaned P.G. entered the foul gas mains at a temperature of about 140° F. through a controlled butterfly valve.

The author had indicated that dilution with P.G. was not necessarily a long term policy. The speaker would say that B.W.G. was preferable for regular dilution, but facilities should be available to add P.G. and to carburet the water gas for peak loads. That policy could readily be associated with the installation of mechanical producers for retort setting heating. A new carbonising plant ordered for Birmingham would consist of Woodall-Duckham continuous vertical retorts capacity 8½ mill. cu.ft./day equipped with Humphreys and Glasgow mechanical producers, with arrangements for drawing off producer gas for dilution and cleaning it before admission to the foul main. The coal gas would be produced at 490/500 C.V. and operate in conjunction with a 2½ mill. cu.ft./day water gas set which would normally operate as a blue plant. At peak demand periods, the water gas would be carburetted as necessary and producer gas added up to 10% of the total or possibly more.

## Long and Short Term Practice

It was a very important point that the substitution of producer gas for blue water gas as a diluent (whether the blue water gas was produced externally or within the retorts) involved the carbonisation of more coal and the production of more coke for sale. Were those conditions acceptable as accompaniments to producer gas dilution as a regular practice over a long term, as distinct from peak load or short term use of producer gas for dilution ?

Mr. **H. S. Cheetham** (Humphreys and Glasgow) said that the author had certainly given a most interesting paper on the subject of producer gas, and he desired to congratulate him on the work which he had done.

Mr. Hubbard had acquired producers rather the hard way. He bought second-hand producers from the Ministry of Supply which were unsuited to buildings and local conditions, and those who had been concerned with the moving of plant from one station to another had a good deal of knowledge of all the difficulties which could be encountered in that connection.

With regard to the question of mechanical producers versus step grate producers, more time was required before one could generalise, and even then he was doubtful whether one could generalise, because cases varied so much from works to works and from country to country. It was the general view that where step grates were operated under ideal conditions, the saving effected by mechanical producers might be small; but it was also the view of many that those ideal conditions for step grate producers were not as numerous as they were, and were rather inclined to decrease. Labour conditions were making it increasingly difficult to secure the right type of people to look after step grate producers, whereas the technicians to control mechanical producers would, in his view, be more easily obtained in the future.

Of course, in the circumstances in which the author had acquired his producers, it was noticed that he had a large number of them. He had no less than nine producers, and so far as economical working was concerned, Mr. Cheetham's opinion was that the trend in the future would be to go for larger producers. There were producers in operation in works which were gasifying something like 80 and 90 tons per unit, which was only applicable to the larger works; but it was a very real means of effecting economy.

On the subject of breeze, it seemed that the author had made a good case for the sale of breeze to any consumer other than his mechanical producers ! He agreed with the author in that respect. He had pointed out all the difficulties associated with the gasification of breeze, and it was interesting to learn from the paper that there seemed to be a tendency for a decrease in the differential between the price of coke and that of breeze. If that were to continue, then it would appear that the case for breeze in mechanical producers might well disappear.

With regard to cleaning, it was noticed that the author had been obliged to install an exhauster in order to overcome back pressure. It was not known whether it was his opinion that that would be required on future installations, but he suggested to the author that satisfactory cleaning could be obtained without that additional complication. There was an installation working at Pitwines which did not include any boosting or exhausting plant, and it was thought that time would show that the degree of cleanliness of the gas was entirely satisfactory.

## Story with a Moral

Mr. **J. E. Davis** (South Eastern Gas Board) said that the Institution was much indebted to Mr. Hubbard for such an interesting story of his experience with producers. Like some of the improving stories which were told in youth, it had a moral, and that moral, quite properly, came at the end. It was: ' In conclusion, it may be suggested that the wages of an operative are not completely covered by the pay packet, and that a proportion of his wages may be in the form of improved working conditions.'

At the end of the war when raw material costs and wages costs were rising very rapidly, there were many people who felt that the chance had been given, which they had not had before, to put in labour saving, fuel saving, and all sorts of other saving devices, in fact, all the things which they had long wanted to do but which had previously not been economical. It looked very good, but, of course, those who thought that there was a permanent change in the economic balance were led astray, because it was not long before it was realised that the cost of putting those saving devices in had also risen. Indeed, that was the position with regard to mechanical producers and such like devices for improving working conditions. If it be true, as was suggested in a recent discussion, that quite a considerable part of the capital cost of modern plant could be saved if no request were made for some of the things which were asked for, and if that difference were to be brought into account in the form of an annual charge, that annual charge might be quite a high proportion of the total operating wages cost.

In the author's story there were three quite distinct threads. He had spoken of the use of external producers as contrasted with built-in producers in the heating of carbonising plant; he had referred to the use of low grade fuel as compared with graded coke, and to the use of mechanical grates. Thirty-five years ago the former South Metropolitan Company introduced external producers for the heating of horizontal retort plant with the object of improving working conditions in the retort house and preventing slag attack on refractories. Some ten years later they tried the second thread, the use of coke scalpings in order to improve the quality of the coke. Over a period of years the difficulties which were encountered pointed more and more clearly to the fact that if the job were to be done at all, it must be done thoroughly. If the producer gas were to be made in external producers, the sensible heat of the hot coke producer would be lost and most of

the sensible heat of the hot producing end, and it was a wise move to lose the whole lot, because if an endeavour were made to conserve half, difficulty was encountered with dust. It was better and, in the end, necessary to clean the producer gas thoroughly. In his view it was the finest dust which was the most difficult to remove which produced most trouble in slag attack.

Having removed the heat from the producer gas it was necessary to regenerate or recuperate thoroughly, otherwise the theoretical flame temperature, the hot gases, and the familiar efficiency relationship $T_1 - \frac{T^\circ}{T_1}$ came back again and pushed up fuel consumption.

In plant where there was efficient generation, as in coke oven plant, and where one could afford to clean the producer gas thoroughly, then the use of the external producer with mechanical grate and cleaning plant became an economic proposition; although even in that case he would not increase the already high cost by wanting twice or two and a half times as many producers in order to burn a fuel which was somewhat cheaper.

## The Step Grate Producer

The Metropolitan Division of the South Eastern Gas Board had gone back to the step grate producer. By paying attention to the design of the step grate, providing ample grate area and ample capacity for fuel in the producer, and by arranging ash removal facilities, the work was not onerous. Certainly the cost was far less than that of mechanical producers, and certainly of any of those combinations using low grade fuel.

Mr. **R. W. Crowther** (W. J. Jenkins & Co.) said that mechanical and step grate producers had been the subject matter of discussion at the Institution and other associations on previous occasions, and the pros and cons had been fully ventilated. The author in his paper had again floodlit the subject in relating his experiences in the Liverpool undertaking.

His few remarks would be confined to the application of such producers to the heating of carbonising plant, and in particular to intermittent vertical chambers and horizontal retorts. In that respect, the subject might really be narrowed to a comparison between the mechanical and manual removal of ash following the gasification process.

There was no doubt that if the industry were to attain the 85% thermal efficiency in carbonisation to which the President referred in his Address it would not be assisted in so doing by the external producer and mechanical ash remover, even if providing hot gas, and certainly not if the gas were ashed before reaching the settings. The technical reasons would be too well known to require repeating.

Without reiteration of the many minor advantages and disadvantages of both types, he felt, in substance at any rate, that the question could be narrowed down to a few issues only, *i.e.*, (i) the partial elimination of semi-skilled labour, (ii) the provision of clean or semi-clean gas for combustion in the settings, and (iii) capital cost.

Those points had been dealt with previously, but it was felt that a further brief analysis would not be wasted by particular reference to the paper under discussion.

On the question of labour saving, no general case appeared to have been made when converted into terms of £ s. d. The partial reduction of unskilled labour had to an extent been replaced by additional skilled labour in the greatly increased maintenance, which was, of course, inevitable, with any mechanical plant dealing with either coke or ash. It might be claimed under ideal conditions of fuel supply, with low ash, that the hard work had been removed, but it would be interesting to know from the author whether, under high ash conditions (which were more the rule than the exception in present times) that was so. He had seen very hard work put into stirring the fuel bed from the top poke holes of producers.

In the case quoted by the author, where the existing producers were situated in cellars, there was no doubt that a good case could be made for external producers. Manual work under such conditions, legacies of 30 and more years ago, should not, and indeed, would not be tolerated.

In other cases quoted by the author, he felt that to modernise the step grate producers might have been possible at very much lower cost and made available the space for coal gas plant. In his experience there were few cases where grates in the older settings could not either be deepened or widened to give a grate area which would conform to a reasonable standard of gas production. Such converstions, for which he had been responsible for designing, particularly as applied to existing horizontal retort settings, had followed the lines referred to by the author, and described by Mr. Moys in his paper to the Southern Association earlier in the year; *i.e.*, with the producer at one end and the recuperation at the other. In every case the conversion had given a more than adequate grate area, and led to more consistent and regular heating of the retort, higher working temperature throughput, and eased the manual problem. He could confirm Mr. Moys' experience. The cost was fractional compared with external producers.

Regarding the provision of clean gas for retort settings, quite obviously it had its advantages in flue cleaning, but was it not still a fact that retort life was decided by the coal side condition and not the flue side ? At least, that was the general experience in his view. It must of course be admitted as the author suggested that in due time that might be changed, but it was not in sight yet.

The author freely admitted the higher capital cost of the separate producers themselves, to which—a point often lost sight of—must be added the capital charge for screening plant, a necessary adjunct to mechanical producers to avoid adding even further capital charges for the provision of more producers if lower grade fuel must be used, and, as the President suggested, was likely to be the case.

The author had given the Institution the benefit of an almost unique experience with mechanical producers in this country, which would be of great value to the industry. It was, however, difficult not to feel that the future trend of gas manufacture would, by sheer force of economic circumstances, tend towards reduction in capital costs of carbonising plant per unit of gaseous thermal output, rather than the increasing costs which were inevitable with the separate producer. Not only that, but consideration would always be necessary to ground space required for carbonising plant which, based on the illustrations contained in the paper, would appear to be approximately doubled, and in one case increased by about 33%. Even with entirely new plant he found the increased ground requirement in the region of 25%.

## Flame Temperature

Dealing with one or two specific points in the paper, the author had outlined his difficulties in obtaining a satisfactory flame temperature. That was probably in a large measure due to the initial quality of the producer gas and possibly to incomplete combustion of the gas. There was a good margin between the theoretical and the actual temperature requirements. He had encountered no difficulty in attaining a temperature of 1,375-1,400° C. with air admitted to the combustion chamber without appreciable preheat in the region of 100° C. A high excess of air content in the water gases, equivalent to a $CO_2$ content of 16-17% would often give equally high flue temperatures.

The author had referred to continental experience in retort life, inferring that such was due to the introduction of cleaned gas. The author would, from his experience, doubtless know that such applied also to retorts with internal producers. From his own experience over many years he could only conclude, and it was borne out in this country, that such increased life was more attributable to the much lower average working temperatures found on the continent, particularly in Germany. Temperatures in excess of 1,250°-1,275° C. were often looked upon with some degree of alarm.

In conclusion he felt that the answer to the question of producer practice, or ash removal from the producer, might be in a marriage of the two systems, combining the thermal advantages of the internal producer with mechanical as distinct from manual removal of the ash.

Mr. **F. S. Charnley** (North Eastern Gas Board) said that he would confine his remarks to discussing one or two small points which had been brought out in the paper in the light of receiving further information.

The author had compared the performance of the single-cell and multi-cell dust extractors. As extractor efficiency was a function of the square of the angular velocity of the gas in the centrifuge, it would be of interest if the author could give some idea of the size of the Vortex type of dust extractor and the back pressure thrown. Without those it was difficult to understand the reason for the improved efficiency obtained with the small diameter multi-cell extractor.

The paper rather gave the impression that the multi-cell extractor necessitated gas boosting as distinct from the Vortex type. In actual fact it was difficult to see any reason why the pressure drop

with the multi-cell extractor should be greater than with a single centrifuge. It might be that mechanical power had been necessary at Wavertree to obtain the higher gas velocities required to ensure that there was no deposition of dust before or after the extractor. If so, it would be interesting to know whether that had been successful.

It would also be interesting to know whether there had been any tendency for the relatively small gas ways in the multi-cell extractor to become blocked, and also whether there had been difficulty in handling the very fine dust from the extractors.

When discussing the merits of electro-static detarrers, no mention has been made of the saving in power which should result from the replacement of mechanical cleaners by electrical precipitate. That must be considerable on plants of that size, and he would welcome the author's comments on that aspect.

The author had also spoken of 3-9 in. producers. That was, of course, a printer's error; but the reference to producers by size gave the average gas engineer little indication of their output.

It was rather a pity that space did not permit details being given of the many and varied engineering problems involved in the design of those installations, as it would have added rather to the usefulness of the paper if the author could have given a lead to the engineer who was desirous of carrying out similar work.

## Gasification Rates

Mr. **G. Milner** (Power Gas Corporation, Ltd.) said it was unfortunate that shortage of time available precluded the paying of adequate compliments to the author for a paper which contained so much valuable technical information and matters of a controversial character. It was so full of good things that it was impracticable to deal with it adequately in a brief verbal statement, and he therefore proposed to confine his remarks to a few salient features which were of special interest to the company which he represented.

The rates of gasification of carbon, given on page 7 of the paper, expressed as pounds gasified per hour per square foot of generator area, appeared to be rather low. It was well known that the character of the fuel controlled the rate at which it could be gasified, and as the maximum rates normally achieved at Liverpool amounted to only 20 lb. of carbon/sq. ft./h., it must be concluded that the fuel was one of a difficult type.

In this country there were plants of similar design to those in use at Liverpool successfully gasifying coke nuts at rates of 35-40 lb. of carbon/h., while recently at a new installation abroad graded coke nuts had been gasified at rates as high as 50 lb. of carbon/hr./sq. ft. That plant was of similar design to that used at Liverpool, although conditions of operation were different. In both those instances the plant was supplying cold clean gas.

The difficulties of gasifying coke breeze were well known and called for little comment, other than that the author and his staff were to be congratulated on achieving the thermal efficiencies reported.

As to the size of generator, the great difficulty in operating a 7 ft. 6 in. diameter generator as compared with a 10 ft. 6 in. diameter generator was an experience not previously appreciated by his firm. It was relatively rare for them to install generators of different sizes on the same job, and consequently differences in generator performance on different jobs were usually attributed to the characters of the fuels being gasified.

## Gas Cleaning Equipment

In the paper there were errors of nomenclature. Theisen gas cleaners were not supplied with the plant installed at Liverpool. The gas cleaning equipment included centrifugal cleaners of the water washing type; but as those devices were usually followed by dry scrubbers for the removal of the finer dust particles, their performance was inferior to that of Theisen cleaners. The Theisen cleaner was capable of giving a degree of cleanliness better than 1½ grains of dust per 100 cu.ft. of gas.

Reference was made in the paper to certain features of design which were subject to some degree of controversy. To cope with the problem of feeding the large quantities of fuel, which must be handled at high rates of gasification, *i.e.*, at rates of the order of 40-50 lb. of carbon/sq. ft./hr., it was thought that the gravity feed of the type now in use at Liverpool possessed considerable merit, particularly in respect of ease of maintenance and absence of manual effort during the charging of coke.

At one of his firm's recent plants almost 2½ tons of graded coke/hr./generator were being charged, with practically no manual effort on the part of the plant attendant other than opening and closing a chain operated sliding valve. The wear and tear on the equipment was small. With graded coke, the multiple chutes, employed for the distribution of coke breeze, were unnecessary.

Where the gasification of coke breeze at low rates of combustion was contemplated, and where not more than 8-10 cwt. of fuel were to be added per generator per hour, then a case more favourable to frequent manual charging might present itself.

Again, in avoiding segregation in the fuel bed, *i.e.*, when gasifying breeze, experience had led him to believe that the static type multiple chute distributor suffered less wear and tear and was easier to maintain than other types of gear. It must be borne in mind that wet coke breeze was corrosive as well as abrasive.

Where it was intended that different sizes of fuels were to be gasified alternately, then a compromise between different methods of charging might be the better solution.

It should be borne in mind that most of the units installed at Liverpool were not specifically designed for their present duty, and therefore greater convenience in operation might be achieved by suitable modifications. That was true of the changes made to the depth of the vaporiser jacket described.

## Cleaning of Hot Gas

The effective cleaning of hot gas was recognised as being a more difficult problem than the cleaning of cold gas. The relative inadequacy of the more simple Vortex type of dust extractor was partly due to an insufficient appreciation of the problem, and when it was appreciated a more complex device was installed.

In addition to the later type installed at Liverpool, there were other highly efficient types of dust removers available. The Multicyclone of Messrs. Pratt-Daniell, which was the first in this country to employ the principle of a combination of small cyclone units, had an exceptional performance. It should be emphasised that where cold clean gas was of value, the Theisen cleaner could reduce the dust in the gas to less than 1½ gr./100 cu.ft.

The Lynn washer normally served a dual purpose, namely, the removal of the heavier dust and the cooling of the gas. The water requirement for dust removal was usually in excess of that needed for cooling so that the high temperature given in the paper, namely 40° C., must be due either to inadequate water supply, or to the use of warm water or both.

The results given in Table 5 confirmed that a strong case could undoubtedly be made for the well designed step grate producer. Retort coke was, however, used during the Atholl Street tests, and therefore he would stress the comments made by the author on the upgrading of the value of coke available for sale.

## Economic Efficiency

Although as shown in Table 6 there was an apparent loss of thermal efficiency due to the use of cold producer gas, the gain in economic efficiency which was the item that really mattered outweighed all other considerations. That was well worthy of consideration by all who were interested in the problem of retort heating by producer gas.

It would have been of interest to seen an analysis of the type given in the paper applied to the tests recorded in Table 5. In that instance it was feasible that the inferior thermal efficiency shown by the mechanical producers when compared with the performance at Atholl Street, might have been more than offset by a gain in economic efficiency.

Although in a paper of such length there appeared at first sight a number of inconsistencies and a certain amount of vacillation on the part of the author, it was apparent that the problem as a whole was far too complex to permit of a simple answer if a fair assessment were to be made. Consequently the author could not come out strongly in favour of either mechanical or step grate producers.

It was perfectly clear, however, that the author knew what was wanted at Liverpool and had decided how it was to be done. His confidence in the installation and use of mechanical producers was paramount, and that overruled any open mindedness with regard to the general case as expressed in the closing paragraphs of the paper.

He was to be congratulated on the courage and pioneer spirit which he had shown in tackling his production problems in such a progressive manner.

The **President** said that the author would be invited to reply to the discussion in writing.

# Personal

Mr. **F. M. Rogers** has been appointed to the Board of Sidney Flavel & Co., Ltd., Ironfounders and Engineers, Leamington Spa, in the capacity of Sales Director.

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Mr. **John Bithell,** M.M., Yard and Purifier Foreman at the Windsor Street works of the Birmingham undertaking, West Midlands Gas Board, was awarded the British Empire Medal on the King's Birthday for service in connection with social and welfare work.

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Mr. **Joseph T. Broughton,** who prior to vesting date was Engineer, Manager, Secretary and Director of the Haslingden (Lancs.) undertaking, has retired after 58½ years in the gas industry, 49 years as Engineer and Manager of various undertakings.

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Mr. **Stanley B. Rippon** has been appointed General Sales Manager, Heavy Constructional Division, Thorncliffe Ironworks, Newton, Chambers and Co., Ltd. The word 'sales' was inadvertently omitted from the announcement of Mr. Rippon's appointment last week. The General Manager is Mr. G. G. Ibbotson.

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Mr. **D. M. Henshaw,** Chairman of B.H.D. Engineers, Ltd., and the Bryan Donkin Company, Ltd., has recently returned from a visit to Spain. He was on the Continent at the time of the visit of the Yorkshire Junior Gas Association to the Chesterfield works of the Bryan Donkin Company (reported in the *Journal* of June 7), and Mr. Lewis Seaman, Managing Director, prefaced the luncheon speeches with an expression of his apologies to Dr. R. S. Edwards, Chairman of the North Eastern Gas Board, and the other guests.

# Obituary

Mr. **James Dryburgh Fleming,** who died at Glasgow on June 14, was for many years Secretary of the Scottish Road Tar Association and was well known in trade circles in Scotland.

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Mr. **Frank Blackburn,** A.M.I.C.E., A.M.I.MECH.E., for many years Chief Engineer and General Manager of the former Plymouth Corporation Gas Department, died suddenly at his home at Truro on June 14, aged 54. When the industry was nationalised last year, Mr. Blackburn was appointed Manager of the South Cornwall Sub-Division of the South Western Gas Board, which combines 18 undertakings, and he held that post up to the time of his death. He was educated at Leeds University, and after a period on the technical staff of W. J. Jenkins & Co., Ltd., he joined the Leeds Gas Department in 1924 as an assistant at the Meadow Lane works. During the 1914-18 war he served with commissioned rank in the East Yorkshire Regiment in Gallipoli. Returning after three and a half years' service overseas he was for a time Assistant Superintendent in the meter, stoves, and stores department at Leeds and he joined the Plymouth undertaking in 1927 as Chief Assistant Engineer. Only a month later he was promoted, at the early age of 31, for such a post, to the post of Chief Engineer and General Manager. In the 1939-45 war he was a Major in the R.E. section of the Home Guard at Plymouth, and between the two wars he served with the Territorials. Mr. Blackburn was President of the Southern Association of Gas Engineers and Managers for three years (1939-41).

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The Report on the Chemical Industry, 1949, prepared by the Association of British Chemical Manufacturers at the request of the President of the Board of Trade, contained a chart setting out the principal products of the chemical industry, showing broadly how the starting raw materials are further treated and made into final products for most other industries. It was suggested to the Association that the chart might be of interest to chemistry students and others who might not wish to purchase the complete report. An enquiry among the chemistry departments of universities has brought considerable response, sufficient to justify the Association reprinting the chart and making it available separately from the report. The cost is 1s. per copy, post free, cash with order. Applications for copies should be made to the Association at 166, Piccadilly, London, W.1.

# Diary

**June 24.—London and Southern Junior Gas Association:** Summer Visit and Ladies' Day, Brighton.
**June 24.—Western Junior Gas Association:** Summer Meeting and Ladies' Day, Bath.
**June 24.—Wales and Monmouthshire Junior Gas Association:** Ladies' Day, Weston and Cheddar.
**June 26.—West Midlands Gas Consultative Council:** Gas Offices, Edmund Street, Birmingham, 2.30 p.m.
**June 27.—Southern Association of Gas Engineers and Managers:** Summer Meeting, Cambridge.
**June 29.—North Thames Gas Consultative Council:** St. Ermin's Hotel, Westminster, S.W.1. 2.30 p.m.
**June 30.—Northern Junior Gas Association:** Annual General Meeting, West Hartlepool.
**June 30.—Waverley Association of Gas Managers:** Annual Meeting, Y.M.C.A. Hall, 14, South St. Andrew Street, Edinburgh, 10.15 a.m., following by luncheon at North British Station Hotel, Edinburgh, 12.45 p.m.
**July 4.—East Midlands Gas Consultative Council:** Guildhall, Nottingham, 2.30 p.m.
**July 4.—South Eastern Gas Consultative Council:** 4/6, Wandsworth Road, S.W.8, 2.30 p.m.
**July 10-15.—Fourth World Power Conference :** London.
**July 11.—British Standards Institution:** Annual General Meeting, Council Room, 24, Victoria Street, S.W.1. 3 p.m.
**July 14.—South Western Gas Consultative Council:** Meeting, Taunton, 11 a.m.
**July 17.—Eastern Gas Consultative Council:** Connaught Rooms, Great Queen Street, W.C.2. 2 p.m.
**Sept. 5-7.—Irish Gas Association:** Annual Meeting, Limerick.

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## TRAINING IN INDUSTRY

Mr. D. R. Thomas, chief education officer of the United Steel Companies, Ltd., stressed the need for a scientific approach to training in industry when he spoke at a conference at Ashorne Hill, Leamington, organised by the British Association for Commercial and Industrial Education. Remarkable gains could, he said, be made by efficient organisation. The success of British wartime operations had been achieved by efficient training, and training designed to deal with the skills and techniques of organisation could develop similar efficiency throughout industry.

Mr. F. H. Perkins, Chief Education Officer of Imperial Chemical Industries, Ltd., speaking on the ways and means of training, said that training must consist largely of planned experience—a progressive, long-term, step-by-step process with no promises or guarantees. No isolated course, however brilliant, could ever produce a manager. The guiding principle in the development must be equality of opportunity and the achievement of satisfaction in the job. Channels must be provided through which the best might rise in accordance with their abilities.

Mr. J. A. Hunt, General Manager of the Hymatic Engineering Co., Ltd., and Chairman of the Birmingham District Advisory Panel of the Midland Regional Board of Industry, said many training schemes were not as effective as they might be because they aroused needless resentment and frustration among employees who were not included. Training should improve team spirit, but would only do so if the feelings of all workers were taken into account and not merely those of the trainees.

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Addressing a Press conference at Leeds, Mr. G. R. Strauss, Minister of Supply, said it was true that sheet steel was in short supply, but this problem would be solved when the new plant in South Wales came into full production. At present we were importing sheet steel in order to export, for example, motor-cars—especially to dollar countries. The fact that there was a lack of bottlenecks was one reason why productivity per man had increased so significantly during the past year. There was another factor: the shortage of labour with which to fulfil orders had actually stimulated industry. It had made management put a great deal of thought into organisation or production. This would enable them to meet all the better the competition developing—it had not been serious as yet—from Germany and Japan.

# General Increases in Gas Prices

## Boards Meeting New Burdens

**General increases in the price of gas by 1d. per therm in the Southern area and ¾d. per therm throughout Wales and Monmouthshire were announced last week, the revisions to take effect from the meter readings on and from June 15.**

MR. O. R. GUARD, Chairman of the Southern Gas Board, addressing a meeting of the Southern Gas Consultative Council at Bournemouth on June 14, presided over by Alderman J. W. Moore, said that when he last met the council on the subject of prices he indicated that it was the board's intention to bring into operation by next January a revised tariff structure designed on more simple lines than those now in existence and which would assist in ironing out the inequalities now apparent in certain parts of the area. It was with the greatest regret that he now had to tell the council that the recently introduced and substantial increases in freight haulage charges, petrol tax, purchase tax on commercial vehicles, and the various matters ancillary thereto, together with certain necessary adjustments to the wages structure, had made it imperative for the board to consider immediate action on prices. This did not mean that they were not proceeding with all speed to revise the whole tariff structure, but unfortunately the administrative work involved in examining the effect of these sudden increases in their costs might well delay by several months the introduction of the more permanent tariffs he had mentioned.

### Costs Rise by £400,000

The costs to which he had referred were all direct costs and entirely outside the board's control and amounted to between £360,000 and £400,000 per annum, excluding increases which might be made necessary to certain of their suppliers through the increased haulage of their materials. To meet these increased costs in full would mean an increase throughout the area as from the first meter readings after the date of the notice—namely, June 15. The board and management committee had given the most serious consideration as to the best way to meet the immediate position and after studying every possibility it had been decided that the only fair way to all consumers would be to increase prices in the area by 1d. per therm, which was a little under 6%, subject to certain exceptions where to do so would increase the price beyond the existing planned ceiling.

### Bitter Disappointment

The fact that he should have found it necessary to meet the council on this subject that day was a very bitter disappointment, not only to himself but to all his colleagues both on the board and in the divisions, and he was sure the council would realise that while one might face the possibility of increased costs with equanimity if a greater productive effort could be expected, the increases to which he had referred did not in any way assist to increase either the volume of their business or the service which they might expect to receive from those to whom the money was being paid and were, in fact, a dead load on their revenue.

While they all appreciated the difficulties and problems with which the British Transport Commission and others were faced it was a matter of the greatest regret to the board that such a substantial share of the new burden should fall on the Southern area. The economies to which he referred when he last spoke to the council were beginning to become apparent and in fact the first of their new 2,500-ton colliers was now in service and was showing an even greater saving than the board had anticipated. Further savings had been made which would become apparent in the current year in connection with further development of their coal and coke handling plant and methods and also in connection with integration, insurance, and other similar matters. These economies, substantial as they would become, could not hope, bearing in mind the comparatively small size of the area, to keep pace with the total increases in outside costs with which the board had been faced since vesting day, amounting in total in the area to almost £600,000 a year.

### Integration Programme

Since vesting day the board had linked a number of undertakings most of which had now ceased to operate as production stations, with a consequent reduction in production expenses, and it was their intention to press forward as rapidly as labour and materials made possible further integration schemes so that their gas could be produced at those places where the burden of the various increases was not so heavy and where the undertakings themselves were more economic to operate.

The following undertakings had been linked since January: Camberley to Aldershot; Camberley to Reading; Reading to Aldershot; Reading to Twyford; Twyford to Wokingham; Wokingham to Henley; Bournemouth to Swanage; Southampton to Romsey. Further linkages were nearly completed from Aldershot to Farnham and from Farnham to Haslemere. The board was determined to press for a steady reduction in operating costs wherever they came under the board's control, but the members could not fail to be seriously concerned with those increments which were outside the physical control of the board and managers. Indirect increases in their costs of plant and materials must be expected to follow the transport increase; these it was impossible to assess. They had concentrated a large proportion of their energies on improving the service to the consumer, which was regarded right through the area as being their primary objective, and from reports they had received it would seem that where they had been able to introduce improved service to those undertakings which in themselves were not of sufficient magnitude to give the consumer service to which he was entitled this improvement had been and was being appreciated.

Answering questions raised by members of the consultative council, Mr. Guard said that where smaller and less efficient manufacturing plants were closed down the general practice would be to use the premises as holder and booster stations. There were economic limits to the linking up of neighbouring undertakings. Capital costs of mainlaying were so great that in certain cases it would be found to be cheaper to modernise existing works and keep them going than to lay mains over substantial distances for the sake of drawing supplies from other works. Each problem had to be studied in line with the financial aspects.

### Wage Adjustments

The £600,000 per annum increased costs since vesting date included the increase in freight charges, petrol tax, purchase tax on commercial vehicles, wage adjustments, removal of the freight subsidy on coastwise shipping, and the devaluation of the pound. With regard to wage adjustments it was fair to say that the board had felt it to be its duty to adjust the wages of the lower paid men on a satisfactory basis.

Asked whether coke, tar, and other by-products were bearing their share of the increased costs, Mr. Guard said the Ministry had authorised an increase in the price of coke, but it was widely contended that coke was not necessarily competitive with other fuels and there was a limit to the price at which it could be sold in a competitive market. The board was satisfied with its tar markets. The 1d. per therm increase would, it was estimated, just about meet the increased costs.

In accepting the statement, the consultative council expressed its thanks to Mr. Guard and the members of the board —all of them business men who knew what they were doing, and in whom they could have the greatest confidence. Mr. Guard, replying, said he appreciated the loyal work done by the staff at all levels. There was no extravagance anywhere. The board was running the industry in the area on commercial lines, and would continue to do so.

### Position in Wales

Mr. **T. Mervyn Jones,** Chairman of the Wales Gas Board, in a similar statement to the Wales Gas Consultative Council at a special meeting at Cardiff on June 13, said it was estimated that the total effect of the outside increases would be to increase the board's expenditure by £158,500 per annum. The board was compelled by the Gas Act, 1948, to secure that its revenues were not less than sufficient to meet its outgoings. In any event, common commercial prudence demanded that gas, like any other industry, must balance its accounts. In June, 1949, therefore, the board revised certain of its prices to secure this object in the near future, and had it not been for these recent increases that object would have been achieved. These

increases, however, had now been imposed and their cost to the board must be met by increasing the present revenues. And so the board had no alternative but to increase the price of gas to its consumers.

The increase now proposed was 0.75d. per therm throughout the area and the increase would take effect from the meter readings for the current June quarter. There would be exceptions to this general increase in the case of certain special contract and industrial consumers. Further, where the present price of gas in any district was 1s. 9d. per therm or more, there would not be any increase in that price.

The board regretted the necessity for its present decision but it was confident that the people of Wales, whose interests the board sought to serve, would agree that the decision in the circumstances was the right and proper one. The board had achieved economies in the operation of the industry in its area, and it anticipated still further in the future. Full account was, and would continue to be, taken of these economies in the interests of all consumers, and in limiting the present increase per therm.

The council approved the decision of the board and expressed satisfaction as to the manner in which the board was dealing with the increased costs now imposed upon it.

## Price Problems in Wales

Sixteen out of the 26 members of the Wales Gas Consultative Council heard at their meeting at Cardiff on June 2 the declared policy of the Wales Gas Board that in order to safeguard the financial structure of the industry in Wales it was likely to adopt a 'go slow' attitude in fixing uniform gas prices.

Mr. **R. S. Snelling,** Deputy Chairman of the board, made the announcement following the hearing of a deputation from the Nantyglo and Blaina and Brynmawr Urban District Councils asking for a reduction in price. They requested the council to recommend to the board a reduction for gas in their areas of 3d. a therm so as to bring the price in line with the charges operating in adjoining areas also served by the Pontypool undertaking.

Mr. **Roy Jenkins**, Clerk to the Nantyglo and Blaina Councils, said that these areas and Brynmawr paid 1s. 9.67d. a therm—about 3d. a therm more than was paid by the adjoining areas. The Blaina gas undertaking's great fault, he said, was to ask the Abertillery undertaking to help them out two years ago when they were, for weeks, without street lighting and entire 'pre-fab' estates had no cooking facilities. Abertillery supplied 80,000 cu.ft. a day at 8½d. a therm, but to meet the increased demand they started using Yorkshire coal and the price went up to 1s. 0½d., an increase which, in the circumstances, Brynmawr and the Blaina and Nantyglo areas were bound to accept. The expense of repairing defects in their own plant was the fault of a 'certain Government Department.'

**Mr. Snelling** commented that the complaint and the way in which it had been presented was reasonable and justified whatever the outcome might be. With the last changes made in price there had been certain modifications, but if further increases were necessary he believed it would be the policy of the board to give every consideration to those areas in which the price was already high.

Comparative gas charges quoted were: Pontypool 1s. 6½d. per therm, Abercarn 1s. 6.8d., and Abertillery 1s. 5.3d. Mr. Snelling indicated that in view of a £2,680 deficit on the Blaina undertaking's working in the year ended last March it would be difficult to justify the reduction asked for. In view of the increasing costs of which the council were well aware, the board felt it their duty to safeguard the financial situation and go slow in the matter of uniform prices.

Mrs. **H. Harry** enquired whether the position in these areas might not be improved by granting a reduction of one penny on the 1s. 9.67d. rate but it was pointed out that if the council conceded this they would soon be inundated with similar requests. Mr. Snelling added, however, that if the council felt inclined to put forward Mrs. Harry's suggestion he would take it back to the Board very sympathetically.

Councillor **R. G. Shute** (Cardiff) moved that the council reserve its consideration of the position until the financial report was in their hands, but Councillor **J. W. Morgan** (Builth Wells) thought this was merely postponing the evil day. These councils had already been sickened by delays and would, quite rightly, feel aggrieved by this further postponement. He moved, as an amendment, that the board be requested to give the matter their urgent consideration, and, as it was largely a financial matter, the council be prepared to accept the board's findings. The amendment was carried.

Mr. **Snelling** gave an assurance, in answer to a question, that the present price would not go up even if prices were increased elsewhere. 'The board's policy,' he added, 'is to bring all gas prices together; but in the meantime it is their duty to safeguard the industry's financial structure in Wales by going slow in this matter of uniform charges.'

The council was presided over by Alderman **G. F. Hamer**, who extended a welcome to Mr. R. N. Quirk, of the Gas Section of the Ministry of Fuel and Power.

Mr. **Snelling,** in the course of a discussion, referred to the board's policy towards rebates and Councillor **B. Watkins** (Merthyr) wanted to know the legal position in a case which he cited where a rebate had been withheld against the wishes of a consumer. The Chairman expressed his opinion that Councillor Watkins had raised an interesting point and it was decided to communicate with the board pointing out that the council viewed such practice as illegal and recommending that managers of the various undertakings be notified accordingly.

Discussion followed on the rights of consumers under Section 54 of the Gas Act, 1948, and paragraph 16 of the Third Schedule, and Mr. **Snelling** explained that it was an obligation of the board to ensure that the rights of consumers were safeguarded and carried out.

When the council turned to the appointment of 18 local committees nominated by local authorities and other organisations, Sir **Wynne Cemlyn-Jones** (Penmaenmawr) thought it might have been advisable to fix an age limit. There were many nominees whom he considered too old to be able to function efficiently.

It was agreed to hold the next meeting of the council on September 8 at Llandudno.

## Her Happiest Years

Over 50 representatives from the various women's organisations in Northumberland and Durham travelled to Newcastle on June 2 to bid farewell to Miss Mary Strong, Chief Home Service Adviser, Newcastle Division, Northern Gas Board, who is leaving Newcastle to take up her new appointment as Sales Manager to the three Cumberland Divisions of the board.

At this delightfully informal function, which was held in the Demonstration Theatre in Grainger Street, tributes were paid to Miss Strong for her valuable work during the past nine years, and for the help and guidance she had freely given to the various women's organisations in the area.

Mr. J. E. White, Divisional General Manager, Newcastle Division, said that Miss Strong's departure will mean in broad outline no change as they had been very fortunate in obtaining the services of Miss Sheila Dobson as her successor. Since the end of the war it was largely the guidance they had received from the women's organisations which enabled them to plan the proper kitchens for the post-war homes. In going to Cumberland, Miss Strong would be starting from scratch, on unploughed ground, and she had a stout heart to tackle the work.

Miss Strong said that looking back on the 14 years she had been with the Newcastle and Gateshead Gas Company, as it was up until nationalisation, she had found them the happiest years of her life. These years had taught her a great deal and she now realised there was more to the art of housewifery than cooking. She was greatful for being allowed the opportunity of thanking all present for their kindness and encouragement.

Miss Dobsca, in expressing her thanks for the welcome she had received, said she realised how strong the link was between the gas industry and the women's organisations. She intended to aim at the high standard which had been set by Miss Strong, and she would do her best to live up to it.

A vote of thanks was moved by Mrs. Cresswell on behalf of the women's organisations to the Home Service Department of the Northern Gas Board for a delightful afternoon and for their hospitality.

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**Veritas-Efesca Social Club.**— An enjoyable evening was spent recently in the staff canteen of Falk, Stadelmann & Co., Ltd., when the semi-finals and finals of the Veritas-Efesca Social Club table tennis and darts tournaments were played. A total of 58 members of the staff competed in the table tennis and 46 in the darts competitions during the past six weeks. The winners were Mrs. B. Jennings, ladies' table tennis, with Mrs. S. Player as runner up; Mr. C. H. Grant, gentlemen's table tennis, with Mr. A. Kelly as runner up; Mr. C. H. Grant, darts, with Mr. A. Tigg as runner up. The winner in each section received a silver challenge cup and the runners up were awarded table tennis paddles and darts respectively. Presentations were made by Mrs. Walter Thurner, wife of one of the Directors. Miss Lilian Furness, a committee member of the Social Club, handed a bouquet to her on behalf of the Club.